Ambix

The Journal of the Society for the Study of Alchemy and Early Chemistry

Members of Council

Denis I. Duveen, Esq. — Prof. D. McKie (*Chairman*)
Prof. R. J. Forbes — Prof. J. Read, F.R.S.
D. Geoghegan, Esq. (*Hon. Editor*) — Dr. W. A. Smeaton (*Hon. Treasurer*)
Dr. F. W. Gibbs (*Hon. Secretary*) — Dr. H. E. Stapleton
G. Heym, Esq. (*Hon. Foreign Sec.*) — Prof. Lynn Thorndike
Dr. E. Ashworth Underwood

Vol. VIII JUNE, 1960 No. 2

OTHER TEXTS ON COLOURS

By Lynn Thorndike*

I.

In the course of the summer of 1959 I examined more texts related to colours in continental libraries[1]. Several of them may be briefly dismissed. At the Vatican, in latin manuscript 4425, fols. 258v.a–260r.b, colour rather than colours was discussed, its relation to the senses and to light, what colour is and why there are many colours. It opens and closes:

> Dicitur autem sensibile tripliciter quorum duo quidem per se dicimus sentire . . ./. . . Colores autem desuper natatione opportet dicere eodem modo et de commixtis, set qua de causa colorum species sunt determinate et non infinite et saporum et strepituum postea dicemus. Quid autem sit color et qua de causa multe colores sunt dictum est.

* Columbia University, New York.

[1] See my previous paper, "Some Medieval Texts on Colours," in *Ambix*, vol. VII, No. 1, February, 1959, pp. 1–24.

On closer examination the text was found to be a combination of passages from *De anima* and *De sensu* of Aristotle. Its incipit corresponds to the second sentence of *De anima*, II,6 (418a) and its last sentence to the opening of cap. iv of *De sensu* (440b). The excerpt from *De anima* ends at the bottom of 258v.b, shortly before the close of II,7(419a), and that from *De sensu* opens at the top of 259r.a, in the course of cap. i(436b).

In the case of two Latin manuscripts at Graz, one text was only a paragraph in length[2], while the other soon lapsed into German[3]. At Berne, *De arte pingendi* in MS. A.91.17, 11th–12th century, fols. 1v.–5v., turned out to be incomplete and, so far as it went, to be concerned chiefly with the single colour, *clarea*, of which there were two kinds, one made by beating and one by shaking, or sometimes by pressing through wool or straw[4].

Such pressing through cloth or straw, albeit for quite different ingredients, is found in a work on alchemy ascribed to Michael Scot: see Ch. H. Haskins, in *Isis*, **10** (1928), 354, "et subtiliter cribra cum panno subtili vel cum straminea"; also D. W. Singer, *Isis*, **13** (1929), 7–8.

The contents of Latin manuscript 7105 at the Bibliothèque Nationale, Paris, have been duly catalogued by Corbett, who states that its Virgil's pictorial waters at fols. 132r.–138r., were edited by V. Ussani in 1938 in *Studi medievali*. But the reference is incorrect[5]. One may note further the concluding passage about oils of *De modo medendi* by Gerard of Cremona, which occupies the greater part of the manuscript (fols. 1r.–131r.).

> So ends the tractate on oils by master Gerard of Cremona, and consequently all the other tractates compiled by him. The entire book is called *De modo medendi* of master Gerard of Cremona and comprises

[2] Graz, University library, MS. 482, c. 1300, perg. fol. 180v.a, opening, "Cum omnia elementa sunt (*sic*) dyafana. . . ." The paragraph is repeated at fol. 188v.a-b.

[3] Graz 1609, 15th century, fol. 172r., rubric: "Sequuntur magisteria ad faciendum diversos colores et ad tingendum pannos sive colorandum et diversos modos scribendi cum auro et argento et omnibus metallis"; incipit, "Compositio auri musici. Recipe unam partem sulphuris et modicum tere in lapide . . .". At 173r. the text becomes German; there is a little Latin again on 174r.; at 190r. the text ends with a pious peroration.

[4] It opens on p. 1v in the second line from the bottom of the page: "Sciendum igitur duo esse genera clarearum, unum quod verberando, aliud cassando fit. Cassatum certe valde verberata fragilius (2*r*.) sive infirmus est, . . . eo quod sepius quassatum vel transductum per lanam seu per staminium ab imprimentis manu ibidem sumat clü(?) sepius polluit per manus imprimentis digitos circumeat. Qui vero experimento querit ista agnoscere adhibeat unum et aliud (*aliut* in MS) genus videlicet verberatam et quassatam clearam".

[5] In reply to my query, Professor Corbett agreed with the suggestion that, as his Catalogue of 1939 went to press, Ussani probably told him that he expected so to publish the text, but then failed to do so.

practically all the efficacy and utility of medicine. Yet it should be understood that many oils are not included, such as ram oil made from the grains(?) of a ram, parsley oil made from grains of parsley, *oleum masticelon* made from mastic, nardine oil made from nard, castor oil (which is made from the testicles of the castor or beaver (*beveris*), and so ad infinitum.

Of the treatise on colours, at fols. 138r.–155r., which follows Virgil's pictorial waters, further headings may be added to Corbett's initial, "Et primo de vermilione", and his later indications from whom recipes were had.

138v. Ad viride grecum faciendum
Ad faciendum minium
139r. Ad faciendum rosidum colorem
Alia recepta et breviora
139v. Ad faciendum cerusam que vocatur album yspanense
Ad faciendum synopidum colorem pictoribus aptum valde
140r. Alia recepta quam habui a magistro Johanne de Fonte pitore bono
140v. Ad faciendum leviter viride grecum (see *Isis* **22**, 458, n. 13)
Ad faciendum tournesolum sive linthecymen(?)
141r. Ad faciendum tornesolum viride
141v. Ad faciendum azurium
Alia recepta
142r. De lapide lazuli fit modo lombardico
Ad faciendum aurum musicum
142v. Ad faciendum colorem rubeum pro tingendo quidquid volueris
Ad faciendum viride ad tingendum vel scribere
143r. Ad faciendum viride gaudiosum
Ad faciendum colorem albidum
143v. Ad faciendum croceum
Aliud viride. Pone croceum predictum in aqua decoctionis
Ad faciendum nigrum s. incaustum
Ad faciendum nigrum per illuminando super aurum quod fit de funis(!)
144r. Ad faciendum sedimen pergamentis (rather than Corbett's *pro unietis*)
Ad faciendum aquam deaurantem cultellos

The remaining headings and recipes are largely concerned with metals, gems, chemicals and alchemy. We note in passing that the black of glaziers is made of "gagate fortiter mollito" (fol. 147r.), and come to an artificial balsam which is most marvellous. It is made by distillation in an alembic, or as *aqua ardens vel rosacea* is made. The first distillation is called "mother of balsam" and is clear. The second, yellow and pretty thick like clear honey, is called oil of balsam. The third, thicker and yellower, is called balsam and has all the properties of true balsam. Its constituents are turpentine, olibanum, aloes,

and other spices. Thirteen cures by it are listed, of which the twelfth is that it rectifies the nerves beyond all other remedies. It is hot beyond degree and is so penetrating according to Hugo and John of Toledo, cardinals, that if you place one tepid drop on your hand in the sun's rays, it goes through to the back of the hand without leaving any hole. And no wonder, for it perforates the fat of a snake, cold as it is, and perforates a table in an hour's time (fols. 152v.–154v.). The little that remains of our treatise is medical, and the Experiments of Solomon, which complete the manuscript at fols. 155–161, provide another instance of the close association of waters, colours and experiments in medieval manuscripts. Among these experiments is one to make a black water from two white ones, another to turn a red rose white, a third to make white wine red, a fourth is a water that whitens the face, and a fifth is to colour apples or pears on the tree.

The association of colours with experiments is even more evident in a little manuscript at Basel (D.III.23) of the fifteenth century, with a written page measuring about four by three inches. Here *Experimenta naturalia*, at fols. 70r.–79v., begin with such tricks as to burn a house by rain and to light a candle from an image on the wall. Presently we are told how there can be different colours in a single vase, and how each colour can be separated from the others, how roses or other red flowers can be whitened and vice versa, red wine made from white, and water seem wine in colour. To blacken a bath take coals of linden, shave and mix them with oil of henbane. Afterwards hang them up in smoke to dry, and then put in a bath, where anyone is bathing himself, and soon he will be as black as an Ethiopian. The remedy is to wash with water of beans. After a recipe for making ice artificially by use of saltpetre, we are told how to make a colour as splendid as gold. Take one part of yolks of eggs and two parts of chalk. Blacken the whole with coal, hold it a while, then apply saffron with a horn and distemper *cum claro*. With the same confection write with a red onion and salt and urine on papyrus. When it has dried, nothing will show. Then heat it at the fire and it will appear immediately.

For the colour of orpiment and quasi-gold, take the gall of a big fish and break it over marble stone, adding three drops of very good vinegar and skinner's chalk, and distemper as for rubric, and write what you please, which when dried will seem of golden hue[6]. For beautiful green writing use the herb *morella* and green *solatrum* and express its juice on marble, adding a little gummed vinegar and skinner's chalk and violet mixed together, and write what you wish, and it will be very beautiful. Similar use of the gall of a big fish and of the

[6] Cf. *Isis* **22** (1935) 466, "De Colore aureo lombardico."

herb *morella* will be found in one of the two texts printed below: Vienna 5512, fol. 175v. For *morella* see also the Florentine MS., 71r.b.

In our Basel manuscript, after a recipe to keep anyone awake for two nights, comes one for making encaustic:

> Take six parts each of gall-nuts and vitriol, and one part of gum arabic. Pulverize them and pour over them wine or beer, water or urine, and you will have good encaustic.

Two more recipes may be quoted:

> To write golden letters, take gum arabic and soak it in water all through the night. In the morning grind crystal hard, then distemper it with water, as for rubrics, and write whatever you will. Afterwards take any metal you wish and rub it over the letters, until they appear like the metal.
>
> To make white crows, anoint the eggs with cat fat mixed with quicksilver, and they will be white as doves.

Next and finally, two texts on colours are reproduced in full, except for such words, contractions and abbreviations as I have failed to make out; the first from a manuscript of the thirteenth century in the Laurentian library at Florence (Plut. 30, cod. 29, fols. 71r.a–73r.b); the other from a manuscript of A.D. 1436, in the Oesterreichische National Bibliothek at Vienna (Latin, 5512, fols. 175r.–176v.). The older manuscript employs metals largely in the production of colours; the younger manuscript makes more use of vegetation and parts of animals. I have tried to note passages which are found elsewhere or which are very similar.

II.

The text on colours in the Florentine manuscript is immediately preceded by an anonymous alchemical treatise or collection of recipies, opening, at fol. 63r.a, "Scias quod sal armoniacus est melior salium et ipsorum nobilior . . .", of which it is the sole example known to me. It breaks off unfinished at fol. 70v.b before our text on colours begins. Alchemical tracts also immediately follow our text: the work by Richard de Fournival opening, at fol. 73r.b, "Dixit Arturus explicator huius operis, Accepi arsenicum et elegi illud in quo sint vene quasi . . ." and closing at fol. 75v.a,

> . . . et erit bonum et rubeum. Ista sunt que erant necessaria ad operationem expositam. Dixit Arturus qui est Ricardus de Furnivalle, Ne vilependatur operatio ista quia nucquam nisi modo nunc erit filia principis ita nuda;

the *Liber de triginta verbis*, and *Liber de duodecim aquis* that opens, "Libelli huius aquarum series duodecim splendet capitulis . . ."—these three are well known works found in other manuscripts—several paragraphs opening, "Dixit

Morienus . . ." which seem extracts from his treatise "ad regem Calid"; and a brief text at fol. 78r.b–v.b, opening, "In hoc libro meo dico argentum vivum et argentum et maneries operationum eorum . . .", which also is peculiar to this manuscript.

Our text on colours, which is both anonymous and without a title, runs as follows:

De colorum diversitate tractaturi adiuvante divine bonitatis favore quomodo quilibet color fieri debet primo videamus.

Fit enim coloratio que azura vocatur et est nobilior ceteris coloribus in quantum nobilior omnibus, quia superposita aliis coloribus scilicet super omnes colores per se colorantur, quia ad solem quilibet (quelibet in MS.) illuminabitur, quia quod desiccatur numquam color removetur loco. Et si clarificare volueris, ablue aqua, et melius apparebit, et hoc patet super omnes picturas. Nam super pergamenum cum ponatur, oportet ut fiat in tentorio cum illinitur.

Fit autem iste color mediante oleo lini et mediante gummi formatis(?)—i.e. of spikenard—que romano eloquio dicitur classa. Accipe libram gummi predicti et pone in ollam fortissimam et bene coctam, et pone super ignem et sigilla super ollam illam aliam ollam cum terra figuli vel argilla ita bene quod ignis vel sintilla non possit intrare ullo modo. Sed inferiori olla sit foramen parvum ita quod ferrum longum cum manubrio tenere possis et movere gummi quousque liquefiat. Habeat quoque cum oleo lini calido et infunde oleum in predicto gummi, et ne cesses movere. Et cum feceris, extrahe ferrum et proba eius depressitatem, et diligenter ab igne remove, et discoperiens refrigari dimitte. Et notandum quod due partes olei et lini et terciam partem gummi ponere debes, pondere et mensura ad Sarracenas faciendas sive vitreandas sive scutellas sive vitredinas(?).

Accipe cuprum rasum lini linitatum et politur cum felle illiniens, quo siccato iterum et iterum illinies et auri *motura colem.* Et sepius calefac illinitum ad ignem et in quanto plus calefiet intus viridis et sulfuris et usti in vesleris(?). Et cum claro vitro misces et super petram marmoream teres, et si testam vel aliquid vas cavare volueris, ex hiis depinges et in fornacem mites ut rubra appareat refrigerata, viride in testam invenies ad usum ping[u]endi.

Album vitrum ita fiat. Sulfur cum albo vitro tere et in forti olla in fornace mittatur. Et cum conglutinatum fuerit, extrahe et tere et vasa figuli depinge cum viridi et albo, et mitte in fornace; et cum removeris preciosum habebis colorem.

Ad album de plumbo faciendum accipe laminas plumbeas tenuissimas et mitte in ollam cum fedibus urine(?) et cooperi multum bene per mensem, et sicca (*71r.b*) laminas, et album habebis cum vides iterum et pones.

Iterum aliter fit. Accipe laminas plumbi et involvantur in fecibus vini et impone acetum in vase ligneo et colloca laminas ne tangant acetum et claude ne ventus vel vapor intret vel exeat, et in fimo calido inmittantur et cooperiatur, et invenies album in laminis valde bonum et sicut prius ad solem laminas vel ad umbram mitte.

Si de albo colorem rubeum facere volueris, decoquatur in aliquo vase donec sit rubeus sicut minium, et in eodem refrigerari permittas et quasi minium invenies.

Si vis facere peroptimum minium, accipe ampullam vitream grossam et illini eam deforis cum argilla, et ut ignis etiam leviter frangere non possit, et sint (super?) 3 vel 4 lapides ponatur. Et pone in ea duas partes sulfuris crocei et unam partem argenti vivi, sed sulfuris fac *candidissimam*[7] et fac animari(?) lentum ignem de carbonibus, et cooperias, et cum videris exire fumum rubeum, depone et quid super est reserva.

Item si vis facere minium de albo, ut dictum est, laminas plumbeas in aceto involves et secundum doctrinam priorem per mensem custodies et pulverem de laminibus collectum pones super ignem et movebis sepius donec album fiat sicut nix, et tunc tolles ab igne, et ille color vocatur ceruxa. Reliquam vero partem ponas super ignem, et semper movetur, quia nisi semper moveretur, verteretur et esset plumbum. Et sic minium habebis, cum miseris in frigidam aquam.

Item fit etiam alius color qui est rubeus et vocatur altera sarracenica et incemana (incemaria?). Et fit de terra et veteri urcere olla, cum urceo tanguntur vel tinguntur capilli.

Si vis facere colorem roseum, minium cum albo plumbo misces ita: accipe duas partes minii et unam partem albi plumbi.

Item, si vis colorem vatizatum facere, accipe auripigmenti duas partes, et totidem de minio. Iste color temperatur cum aqua, et valde pulcher est idem inter alios colores[8].

Sequitur de colore viridi. Accipe grenagorem—nomen sarracenum est quod vocatur lingua romana caprifolium—et tere in mortario et diligenter fac ebullire cum ferro eruginoso. Et ita colorem viridem habebis aliquantulum (71v.a) nigrescentis. Sed cum aceto hec omnia bullies.

Item alio modo fit viride grecum. Accipe laminas cupreas bene laminatas, et pone in marco putrido et in calido loco, et dimitte per 19 dies. Postea remove laminas cupreas et desicca ad solem et rade. Et valet multum et valde est[9].

[7] MS., *ca-inutissimam*.

[8] This paragraph is also found in Vienna 5512, fol. 175r., last item.

[9] A blank space is left before *est* in the MS.

Item alio modo fit sed non valet tantum quam et precedens. Accipe limaturas cupri libras 4 et combure super laminas cupri, conficiendo cum vino acetoso epresso et de marco attrito(?). Accipe 6 libras terre albe minicce et accipe libras 4 crud et libras 4 gavete et 30 uncias de viridi laminarum aceto, et confice ita: tere certum pondere sicut habes, et cum vino de marco expresso commisces, et desicca ad solem vel ad umbram.

Item fit de alio modo et melius quam alter. Accipe laminas tenuissimas de cupro et prepara in vegete ita ut una non tangat aliam. Postea pone acetum fortissimum et cooperi vegetem et in calido fimo de marco teneatur usque ad 20 dies. Postea remove et rade laminas et accipe viride melius quam umquam fuit nec esse possit. Postea repone iterum laminas, si amplius facere volueris.

Si de quolibet vino acetum facere volueris, accipe fabas coctas vel quasi combustas, et calidas in vino vel acetos pone, et acetus erit.

Item alio modo fit color viridis. Accipe batinos quos volueris et cum melle illini. Postea plumbum album superius pulveriza et super marcum pone ita ut a marco subdi non posset, et cooperi multum bene de eodem marco, et ita stet per 20 dies. Et cum removebis, rade quod invenies in batinis.

Sequitur de nigro. Sic fit nigrum peroptimum de carbone vitis, et melius quam de alia re.

Sequitur de azura. Azura fit multis modis. Accipe ollam novam et calcem vivam. Pone quousque fit dimidia, et imple de fortissimo aceto usque ad infimum, et demitte ita in fimo equi per mensem et in loco calido vel in marco. Et cum removebis quod superius fuerit collige et est azura, et quod remanet feces illius sunt tantum[10].

Item alio modo fit. (*71v.b*) Accipe plumbum album scilicet libram unam, et accipe viridis libras 9 et acetum fortissimum quod sufficiat et in patellam plumbeam totaliter dimitte fervere. Et quod superius nataverit collige et desicca et sic azurum habebis.

Item alio modo et melius. Accipe lapidem marmoreum album et in fimo bene putrido frustatim involve, et inferius fac ignem quousque lapis predictus quasi calx aut creta inter se dividatur et condisus fuerit. In mortario bene teratur et pulverizetur et cum spisso camisio unde aguetur. Et ita accipe libram predicti pulveris marmoris et libram de albo plumbo, et 8 libras de indico carissimo bene camisiatis et confice cum succo de besolum(?) vel cum succo floris gladiolis expresso cum urina.

Item alio modo sic fit. Accipe de predicto pulvere marmoris et in mortario cupreo fortiter teratur et super alium marmorem bene cum alio lapide agitetur.

[10] This paragraph also occurs in Vienna 5512 at fol. 175v.

Et accipe de indico et fac fervere(?) cum aqua et quod supernataverit distempera cum predicto quousque videas quod sufficiat. Et cum feceris super eundem marmorem, dimitte ad solem siccari.

Item alio modo fit sic. Accipe libram marmoris et 4 de indico et confice cum indico, mitte soli, et si nimis obscurum fuerit, misce album plumbum quousque sufficiat, et sic peroptimum habebis.

Item alio modo fit secundum antiquos sarracenos. Accipe laminas argenti tenuissimas et dimitte stare in aceto per mensem in loco calido. Postea remove et habebis bonum azurium et posset poni cum pilo uno ubique.

Item alio modo fit. Accipe laminas argenti tenuissimas et unge cum succo vertesolis(?) vel cum succo albesfetus et desicca ad solem sepe et sepius, et sic habebis bonum azurum, et si nimis obscurum sit, pone album plumbum.

Item alio modo fit. Accipe laminas argenti tenuissimas et dimitte stare in marco per mensem et habebis bonum azurum.

Sequitur de cineroso colore. Iste utatur in succo, cunctis in parietibus et in armis. Accipe quartum et combure et cineres illius accipe 4 libras et libram dimidiam de indico combusto et libram dimidiam de limatura combusta et dimidiam libram de albumine, et confice cum aceto et desicca et sic colorem cinerosum habebis.

Sequitur de auro stellato. Aurum (*72r.a*) stellatum ita fit vel marmoratum vel granatum. Accipe gissum, tere et appone parum de bruino ut aliquantulum color immutetur, et de auripigmento et crocum cenforatum cum illis, et tere omnia simul super marmorem et limaturam aureoli et stanni, tantum de gisso et bruino quantum de auripigmento et de limatura et stanno. Quo facto desicca super marmorem predictum et pulverem aureum habebis tam inter ibi notos quam etiam notos pulveris auri esse videtur et si posset coagulari, totus mundus ex eo deciperetur et colirium poterat deliniri sed metallum non.

Item ad faciendum aurum accipe auripigmentum, tres libras eris et cupri, de magnosia libram unam, et confla simul, et vivabitur luna artificis, et addis illi limaturam et 3 libras argenti vivi, et acetum et sal adities donec argentum vivum limaturam conbibat et fiat malangina et ponatur in olla dure terre cum vino et atramento. Et ollam obturabe cum argilla ubique et in fornacem pones per diem integrum aut per noctem et postea removebis massam ad placitum et invenies podaliter factum.

Item alio modo fit aurum in ripis aquarum fluentium. Accipe longam asserem longitudine 15 pedum et latitudine trium pedum et quasi ibi multas concavitates faciat et pendeat ponendo intus arenam et aquam, et ita quod harena lavatur in aqua, et hoc fac per totum diem. In secundo vero quando debueris recedere terram quam in concavitatibus invenies, pones in una scutella cum argento vivo. Et cum aquam intus apposueris, aquam cum terra totaliter

eicies. Et cum argentum vivum huc et illuc discurrerit, aurum capies et traducendo scutellam ad spuritiam aque, argentum cum auro ad fundum ibit, et ita aurum invenies cum argento vivo involutum. Aurum illud palliola propter quamdam aquam que dicitur palliola[11], quia antiqui non crediderunt invenire alibi nisi in aqua illa quod fluvium est. Imo dicit quidam sapiens magister Ierosolmitanus quod ubi fluentia aquarum reperitur cum arenulis, ibi semper aurum invenitur tam in mari quam in aqua dulci, et non potest aurum melius inveniri nec preciosius.

De inventione colorum dictum est; modo de temperatione dicatur. Primo omnia vasa necessaria cum terra figuli abluantur, deinde cum predictis plumbibus depingantur et cum eadem terra predicti pulveres distemperantur cum oleo lini, et ideo quia verriza non posset capere album nisi primo oleum (*72r.b*) immisset.

Rubeus color et carminium distemperantur etiam cum oleo lini, ubi ponantur super lignum vel super parietes vel pannum vel pergamentum cum albumine vel cum summo vel cum bitumine. Minium distemperatur cum clara vel cum bitumine vel cum gummo (ms. summo) arabico. Eodem modo rosaseus color distemperatur cum oleo lineo vel cum summo si super verriza. Color marga(?) distemperatur cum clara vel cum summo. Viridis color distemperatur cum aceto bullito vel cum succo sambuci vel alicuius viridis herbe.

Azura distemperatur cum summo si ponatur in pergamentum vel alibi. Nam in parietibus cum summo fortiter cum vino bullito vel aceto. Cinerosus color distemperatur cum albumine bullito cum aceto, et si ponatur in ligno vel super pannetum(?) cum albumine ovorum distemperatur.

Niger color distemperatur cum vitellis ovorum aut cum oleo lini. Si volueris purgare azuram, liga in panniculo et fac fluere in olla viridissima et utere postea ad libitum. Et hec sufficiant de coloribus.

Item fit et alius color qui vocatur caminum et est obscurius aliquantulum quam minium et sic fit. Accipe limaturam cupri et eiusdem nate, et combure prius et cum vino de marco abstracto conficies. Et accipies barillum et inunge cum felle usque quo desiccetur ad ignem. Quo desiccato circum inunges pulverizatis limature pulverem et sepe et sepius.

Item cum facere volueris, facies limaturam cum vino de marco prius fortiter desiccatam antequam pulverizetur et ita camminium habebis.

Item accipe terram rubeam et cum felle et limatura bene combusta terram bene fortiter commisces et pulverizabis. Et ita accipe duas libras terre et libram dimidiam limature combuste, et confice et desicca cum felle et ita camminium habebis.

[11] This explanation of the word differs from that in Maigne d'Arnis, where we are referred from *palliola* to *paleola*, which is defined as goldleaf: *auri bractea, paillette d'or*.

Colorem viridem sic fac ad usum scribendi. Accipe folia herbe viridis que dicitur morella eamque cum creta candida super marmorem tere donec fiat liquidum ad usum scribendi. Hoc facto poteris scribere. Sed cave ne nimis de creta ponas (repeated in Vinna 5512, fol. 175v.).

Ad scribendum literas eneas aureas cupreas argenteas aut qualescumque volueris, tere cristallum super lapidem marmoreum subtlissime. Postea distempera cum claro ovorum bis terendo ad modum alterius coloris (*72v.a*) quo scribe quid placuerit et permitte desiccari. Tunc fabricabis literam quocunque volueris metallo, mox ipsius recipiet colorem.

Ovum positum in acetum acerrimum per diem et noctem versit(?) parum de pulvere cornuum arietum combustorum et post desiccatum per 4 dies vel amplius fit durissimum.

Modus molliendi cristallos et alios lapides preciosos. Accipe hircum duorum annorum quem per duos dies vel per 3 ieiunare permittes. Post accipe lapidem pyritum qui alio nomine dicitur flyus et est lapis valde communis et vilis quem super marmorem redigas in pulverem huic addendo de sale et de hoc pulvere pascatur iam dictus hircus. Et locabis ipsum taliter ut urinam colligere possis in qua calefacias quoscumque (ms. quousque) lapides volueris per noctem et diem, et reperies ipsos mollitos mirabiliter (cf. Vienna 5512, fol. 175v.).

Ad idem accipe cristallos bene politos et pone ipsos in catabo habente acetum quo teguntur cristalli. Et cooperias catabum cooperculo crudo. Post suspendas in fornace cum virga ferrea quousque cooperculum plurimum recipiat colorem. Incendas cum lignis olive aut sarmentorum et extrahas a fornace et refrigerare permittas et recipies mollificatos ipsos.

Hoc modo tingere poteris. Accipe fel et pisfel testudinis marini, fel urepili(?), fel capre, fel porcinum. Omnia si poteris habere partes (pariter?) commisceas et imponas cristallos et decoque duabus horis et custodias ipsos a pluvio (MS. pulvera) et vento et frigore donec per se paulatim frigescant et erunt virides ut saphiri vel smaragdi.

Colorem rosaceum ipsis imprimere poteris, si per horam dequoqueris in aceto vel urina de pumaci in quo dequoctum sit lignum basileti vel alumen glacie distemperatum. Et permitte refrigerari ut dictum est et recipient colorem mirabiliter pulcrum.

Obscuras vero gemmas hoc modo polire et elucidare poteris. Accipe peciam marmoream valde planam et lavaberis artificiose super illum cum sapone gallico et aqua calida, sicque obscuritatem perdit et preciosum requiret colorem et lucida fiat.

Lapis aureus hoc modo fiet. Salis optimi et auripigmenti crocei partes equales contere optime, in fundo (*72v.b*) terree olle repones, nec stratum de sale nec stratum de auripigmento ponendo donec impleatur olla et obaceretur olla

luto magisterii et comburetur donec induretur. Post hoc pone pondus quinque drachmarum de hac confectione super drachmas 3 marchaside crocee. Bene tere sic que complendo fiet lapis aureus et pacietur poni sicut vitrum in fornace ut fiat vas quale volueris.

Margaritas aut perlas hoc modo fac. Accipe lapillos albos in capitibus piscium repertos quod subtilissime contere in aliquo mortario mundo. Pulverem autem istum distemperabis cum albumine ovorum ad modum paste et informabis perla mittendo per setas porcorum aut qualescumque volueris formas. Fac etiam impressiones, deinde decoque in lacte albissimo et extrahere et permitte refrigerari, et caveas a pulvere (pluvio) et vento ne corrumpatur.

Colorem vermelionem hoc modo fac. Accipe argentum vivum cui amisceas duas partes sulfuris vivi subtilissime pulverizati non quantitate sed mensuratione solum et istis misceas partem septimam salis albissimi. Postmodum hec commixta est, ponas in ampulla vitrea cum luto magisterii bene lutata, cuius fundus sit latus, collum vero strictum, et decoque lento igne donec ibi appareat fumus rubeus (cf. *Speculum* **I**, 294).

Colorem viridem hoc modo facere potes. Accipe mel per pannum expressum et distempera cum aceto forti et repone in aliquo vase cupreo et obterato et sepelias in fimo pingui et calido per 9 dies et habebis colorem viridem optimum (cf. *Speculum* **I**, 294; repeated Vienna 5512, 175v.).

Colorem rosaceum hoc modo facies. Accipe de ligno brasileto rubeo et rade cum vitro vel cutello minutissime in concilla marina vel in testa vitrea, et superfundas acetum vel urinam vel ovi albumen, quod est melius, et commove et per noctem unam sic stare permitte, tunc imponas parum de alumine glacie et sine quiescere per horam et cum illo operari poteris.

Cinpidem hoc modo facere potes. Accipe de lacte partem unam et de alumine glacie partes 2 et contere in subtilissimum pulverem. Postea accipias urinam bonam quousque tertia pars consumpta sit. Tunc fundas urinam super pulverem et stare permitte per diem et noctem unam terque movendo. Tunc decoque ad lentem ignem semper movendo quousque inpissetur et temperetur in ungue(?) vel in corio sic ut color placeat quia si non addes plus de pulvere quam de lacte.

Modus purgandi azurum. Accipe lapidem durissimum et ponas (73*r.a*) ipsum in aceto forti vel in capitello per diem et noctem aut amplius quousque mollescat et contere in mortario minutissime et reponas interea in acetum, quos contere in lapidem marmoreum cum ablutione (*sic*) ovi. Cum spumescat, tunc superfundas de supradicto capitello et mole fortiter. Tunc sine quiescere et hoc totiens faciendo quousque peroptime sit purgatum. Tunc decoque ex una parte brasil. 5 partes et 2 partes albuminis. Postea permitte desiccari et utere (cf. *Speculum* **I**, 300; Vienna 5512, 175v.).

Ut facias portas argenteas aureas vel cupreas vel sigilla. Accipe pastem (*sic*) mollem et inprimas lapidi vel ligno in quo sint ymagines detl'pcte(?) vel flores. Post supponas illa tabule petream stagneam vel argenteam; tunc tritum(?) secunda vice imprime pastam. Similiter decorare poteris sigillum, si commixta fuerit cera cum pice alba quod est pulcrum(?). Accipe ollam novam et pone in ea laminas argenti puri quantum vis et sic cooperies illam ollam et sigillabis et eam poneas in racemis que procréata sunt in corel'ari. Et bene cooperi de ipsis racemis et dimitte usque ad dies 5, et sic facto ollam extrahe et florem que erit in circuitu laminarum recipe in vase.

Alius sic fit. Accipe duas partes aceti et 3 albuminis et pone in vase eneo per 4 vel 5 dies. Postea ad ignem calefac et pone sub terra per 5 dies. Et cum floridus fuerit, de terra extrahe et pone ad solem usquequo ardescat.

Alius sic fit. Ampullam puri cupri usque ad medium calce inple vel forti aceto. Cooperi et sigilla. Pone in terra calida et dimitte usque ad mensem, et sic habebis azurum.

Viride grecum sic fit. Accipe novam ampullam et pone in ea laminas puri cupri et inple forti aceto et cooperi et sigilla et pone in calido loco vel in terra calida usque ad 4 menses. Tunc accipias et que invenies pones super ligneam et desicca ad solem.

Minium rubeum sic fit et album. Misce in olla 4 laminas plumbi cum forti aceto, cooperi et sigillas, et pone in calido loco usque ad unum mensem et quod erit in circuitu laminarum accipies in aliquo vase fictili. Tunc pone ad ignem et semper move ipsum colorem (calorem in MS.), et quando erit sicut nix, tolles de eo quantum volueris. Ille color vocatur ceruza. Reliqua dimittes ad ignem quousque factum sit rubeum movebis; tolles tunc ab igne et in vase eodem facies (*73r.b*) refrigerari.

Accipe marmor albissimum et in tantum ipsum decoque ut ipsum in cinerem redigas, et postea cum vino morarum maturarum distempera, et postmodum ad solem desiccari facias et distempera et sicca. Cum autem hoc quater feceris, accipe de spuma indicis bullientis in caldario et cum ea distempera ipsum ad solem.

Sinapium sic fit. Accipe sulfur longum et argentum vivum in partes equales et sulfure primo pulverizato simul incorpora miscendo de salvia, si est optimum, et in vase vitreo sicut exterius tere vel glise infacto et ipsam in vase bullias donec fumus niger mutetur in album et album in rubeum. Et hoc est quod dicitur.

Herewith our text on colours ends and is followed by a text opening, "Dixit

Arturus explicator huius operis accepi arsenicum . . .", which is the incipit of Richard de Fournival, De arte alchemica[12].

Rozelle P. Johnson (*Speculum* **12**, 1937, 90) held that our manuscript contains "at least recipes nos. A1, A2, A5, A7," of the *Mappae Clavicula*[13].

A2 reads as follows in *Archeologia* **32** (1847), 187:

> Si vis facere Lazurium optimum, accipe ollam novam que numquam fuit in opus et mitte in eam laminas purissimi argenti quantas vis et sic cooperi illam et sigilla; et mitte ipsam ollam in vindemia que est projecta de orculari, et illic bene cooperi de ipsa vindemia et serva bene usque ad xv dies; et sic aperies ipsam ollam et illum florem qui est in circuitu laminarum argenti excuties in nitidissimo vase. Quod si amplius volueris habere, iterum fac quod supra scriptum est.

The words, *torcular* and *vindemia*, do not occur anywhere in our text. It has twelve recipes for making azure, of which the fourth says to take a new pot, (71v.a), and the ninth and tenth to use *tenuissimas* (not *purissimi*) plates of silver (71v.*b*). Otherwise there seems little resemblance between any of them and the passage quoted above from *Mappae clavicula*. On the other hand, A5 and A7 correspond closely to the recipes for verdigris and minium at fol. 73r.a of our text, there being only such verbal variations as *purissimi* for *puri*, *sex* for 4, *aperias* for *accipias*, and *movebis* for *move*.

Besides contractions which I have had difficulty in expanding, our text contains names of colours and other words which I have not found elsewhere: *besolum*, *gavete*, *minicce*, *grenagorem*, *incemana* or *incemaria*, *batinus*, *albesfetus*, *summa* (for *gummi*), *fel urepili*, *veriza* or *verriza*, *vatizatum*, *vitredias*.

III.

We turn to the briefer text *De coloribus*, in Vienna 5512, where it is immediately preceded at fol. 174v. by a *De molificacione lapidum*, and followed at 177r. by a tract on memory, all in the same handwriting.

De Coloribus Ffaciendis

Minium sic fit. Recipe pley weyst et pone super ignem et move donec album fiat, et tunc pone ab igne, et iterum ponatur ad ignem et moveatur et fiet rubeum, quod vocatur minium etc. Item duas partes minii et unam partem azorii plumbi comisce simul et habebis roseum. Item auripigmentum et

[12] Thorndike and Kibre, *A Catalogue of Incipits of Mediaeval Scientific Writings in Latin*, 1937, col. 210; D. W. Singer, *Catalogue of Latin and Vernacular Alchemical Manuscripts in Great Britain and Ireland*, I (1928), item 174.

[13] "Some Continental Manuscripts of the *Mappae Clavicula*", *Speculum*, **12** (1937), 84–103.

tantum de minio et misce cum aqua. Item rade brisilium et buliatur cum urina et inponatur. Bacca et alumen pulverisatum buliantur simul sicud carnes et tres partes de brisilio et quarta pars de bacca et alumine, et tantum de bacca quantum de alumine.

Item in mense Marcii quando herbe sucum suum a terra recipiunt, recipe subulam et locatim perfora ramos edere. Ex quibus liquor egreditur de quo sangwineus color per decoctionem conficitur. Hunc liquorem cum aqua urine decoque et habebis colorem sangwineum. (This paragraph is presently repeated: see below.)

De temperacione colorum. Album plumbi temperatur cum oleo lini, niger color cum oleo lini vel cum vitello ovorum, roseus cum gummi vel cum oleo.

Si quis scripturam querit sibi scribere pulcram, ex auro legat quam ubi(?) carmino dico. Aurum cum puro mero molat utraque solutum. Hoc minium fuerit. Moneo quod sepe lavetur, namque deposcit(?) candida pagina libri. Exm(?) thauro faciat pinguedine fellis. Hoc liquidum seu cum pinguedi gummi(?) atque rogo pariter calamo cum ceperit aurum illud comoveat pulcre si scribere querit. Siccata cum fuerit scriptura intentem hanc minium faciat ursi cum dente feroci etc.

Colores in varios qui vult mutare colores causa scribende quam libri conpagina poscit zophus ut segetes in summo mane peragret et tunc diversos flores ortuque recedens decrepat veniatque domum ut ponat in unum (vinum?) ac super equalem petram bene conterat illos, privatim gipsum hos vero admiscens optime coctum. Sicque igitur siccos poterit servare colores ex quibus in viridem si vis mutare colorem, calcem comisce cum floribus inde videbis quod tibi mandavi veluti ipse prius probavi.

Rogatus a te ut tibi dicam de edera brzyehian quam poeta atque artifices nimium diliguntquia (que in MS) occultas vires quas in se continet cognoverunt. Artifices enim ex hoc multos inveniunt ex quibus unum in hoc scripto ostendam.

Mense Marcio cum herbe atque arbores sucum a matre(?) terra suscipiunt et iterum virtutem crescendi resumunt, subulam accipe et ramusculos edere perfora locatim et egredietur gummi liquor ex eis de quo excoquendo sanguineus liquor efficitur que lacta nuncupatur. Decoque ergo gummi hoc cum urina viri, si potes habere, deponendo spumas. Deinde appone gummi liquorem quem tibi dixi et habes rubeum colorem qui est utilis scripturis atque picturis et ad tingendum pelles. Ex eodem pertia efficitur qua arietis lana ac caprarum roseo colore decoratur.

Si vis facere nazaretum, accipe auripigmentum et totidem de minio; iste color temperatur cum aqua et est valde pulcer.

De edera (bottom margin).

(175*v*.) Ex fellis pingwedine si cupis clipeum deaurare, illum in primis cultello rade ac deinde festina lucidum facere cum ursino dente frigefacto de thaurine fellis pingwedine super illud cum pincello facile trahe, cumque siccatum fuerit auro super hance pingwedinem trahe et cave ne plus trahas pincellum in unum locum quam in alium, sed sit equaliter fellis liquore coopertum. Ne tibi falsum videatur quod dico, hanc artem esse veram probavi etc.

Fel magni piscis alicuius accipe et eius liquorem super petram marmoream rupto folliculo effunde et guttam veteris aceti ter admisce. Hoc facto cretam candidam cum pingwedine eiusdem fellis tere fortiter et convertetur in optimum colorem, qui est auripigmento similis et est aptus scriptoribus et pictoribus etc.

Aurum cum vino mole et postea lava et cum murino felle misce et postea dente castoris vel apri nitere fac.

Ad molleficandum lapides (marginal heading)

Accipe hyrcum trium annorum vel duorum et claude eum in loco, ubi tribus diebus nichil comedat vel bibat. Quarta autem die pone eum in dolio parvum foramen habente et obice ei silicem petrinam, quam Theutonici steynwurtz nominant, et asperge sale cum aqua ut comedat quandolibet aliquid, et sub dolio pone aliquod vas ut urinam eius suscipiat et cum tibi suffecerit, callefac parum et inpone lapide et fiat mollis ut cera etc.

Si vis facere colorem roseum, minium cum albo plumbi misce. ita accipe duas partes minii et tres partes albi plumbi in isto.

Lazurium (marginal heading)

Azurium fit multis modis. Calcem vivam in olla nova pone et mediam inple vino fortissimo et pone in fimo equino per mensem in loco calido et tunc remove et tolle quod superius est. Hoc est enim lazurium, et quod remanet fex est illius.

Lazurium temperatur cum gummi arabico vel bullito aceto et ponatur super lignum vel pannum; cum albugmine ovorum distemperatur.

Accipe folia viridis morelle et eam cum creta candida super lapidem marmoreum tere donec fiat liquidum ad usum scribendi; hoc facto scribe sed cave ne nimis de creta apponas.

Accipe mel per pannum expressum et distempera cum forti aceto et pone in aliquo vase cupro et bene obtuso et sepeli in fimo pingwi et calido per xii dies et habebis optimum viridem colorem etc.

Purgatio lazurii (marginal heading)

Recipe flaveos flores in segetibus et contunde in mortario cum bono vino et reserva sucum in vasculo. Deinde accipe lazurium quod non est purum et tere in lapide, et cum contriveris bene, accipe de lapide et pone in pelvini et funde aquam desuper et lava bis vel ter usque pulcrum fiat, et iterum pone

super lapidem et tere cum gummi arabico et accipe sucum de dictis floribus, immisce simul et operare cum eo, etc.

Recipe montanum id est matu(?) in orto et exprime sucum ex eis et pone in solem et cum induratum fuerit pone parum ad lazurium de suco predicto et mitte stare per noctem. Lazurium tere bene et diu (176*r*.) claro recenti et pone in concham et dimitte residere, et postquam requieverit, proice totum claris et permitte siccari. Cum vero volueris uti, pone clarum intus et tere cum digito fortiter et pone quantum vis in cornu. Summo autem studio provideas ut in omni(?) sero in lazurio similiter et in cinobrio duas vel tres aque guttas mittas, sed semper mane foras proicias et si telam desuper habuerit cum penna tollas et similiter clare abicias.

Illud diligenter observes in temperacione omnium colorum ne de claro nimis apponas, quia de ipsis nullum opus postea facere potes. Lazurium cum claro addens duas vel tres guttas vitelli teres, et cum triveris, lavabis illud in pelvi bis vel ter, et cum satis lotum videbitur, stabit immobile usque dum tollitur. Infundo et tunc effuso claro temperas illud cum simplici gummi cum pincello pinguendum. Si autem cum penna de ipso vis operare, ad gummi quartam partem affunde de claro.

Si vis gummi arabicum artificialiter conficere, accipe gummi de arboribus cerusorum quantum potes colligere, et decoque cum aqua fortissime, et, cum aqua ceperit consumi ab igne, iterum fundas etc. Fac ter vel quater fortiter decoquendo, et sic, cum iam defecerit et bene spissum fuerit, effunde super predictum clarum bene densum et quo luto tamquam bitumine suspendas in tecto ut bene desiccetur. Et tunc temperas ad usendum. Et temperatur sic. Accipe aquam tepidam et pones in vase et dimittes stare per noctem, et in crastino appones ad ignem et decoques aliquantulum, et pone parum de pergamento et colas per panniculum et servas in vitro, et cum illo temperas colorem.

Ad ponendum aurum et lazurium etc. Recipe duas partes vivi argenti et unam sulphuris mundi et conteras cum aqua in lapide quousque fiat ad modum paste et pone in tale vas et pone illud vas super furnum et media in terra et fac subtus ignem levem donec aqua evaporet, quod probandum erit cum cultello si sit madidus, et postea fac ignem fortem donec exeat flamma rubea, et cum cessaverit flamma, tunc cynobrium perfectum est.

Item si desideras cynobrium componere, tolle sulphur cuius sunt tria genera scilicet album nigrum et croceum, quod frangens super lapidem siccum addes ei duas partes vivi argenti equo pondere statere. Et cum diligenter miscueris, mitte in vitream ampullam cooperiens eam ex omni parte argilla et os obstrue ne fumus exeat, et pone eam ad igneum ut siccetur. Deinde pone inter carbones ardentes, et mox cum ceperit calefieri, audies fragmen interius quomodo se vivum argentum comisceat sulphuri. Et cum sonus cessaverit, eice ampullam et apperiens tolle cynobrium sive colorem etc.

Ad faciendam ceram coloratam. Accipe unam partem resine ter tantum coloris contra hec ambo de oleo lini et quater tantum de cera, et simul omnia dissoluta comisce vero vis bine libros cere factoque resine. Sint lini marca tres portionesque(?) coloris.

(176v.) Considera temperaturam incausti diversam. Primo recipe cervisiam prout tibi videtur et inpone ad scisuram pergamenti et mittas horam magnam bullire spumas deponendo. Cum iam tempus videris tibi satis congruum forte quod adhuc tres partes manebunt cervisie. Postmodum recipe ollam in qua vis temperare et infunde illam cervisiam et contritam massam que dicitur vitreolum, et inpone in eadem cervisiam et mittas iterum ad horam aliquam bullire et tunc in fine ponas substantiam etc.

Brisilium sic temperabis. Facias lixiviam de cemento mundo, et cum bene purgata fuerit lixiva colas ipsam(?) diligenter. Precaveas ne ei cementum admisceatur sicque in ipsa lixiva coques brisilium usque dum spissum fuerit ut incaustum. Tunc accipies alumen et conteres illud valde minute factaque fossa in dura crida in eadem mittes alumen, et superfundes brisilium sicque factum(?) dum fieret crida aqua in se haurietur(?) et tota vis brisilii aluno comiscetur. Quidam autem ad alumen duas partes de crida apponunt et sic superfundunt. Utraque autem temperatura cum gummi debet temperari etc.

Si vis facere optimam rosam, accipe brisilium et tere fortiter in mortario, et quantum de illo fuerit tantumdem equali proportione accipe de aluno quantum(?) sufficit et teras in lapide sicca et tunc accipe vitrum mundum et sparge intus partem prisilii, deinde partem aluminis, postea partem crete et super partim spargas usquedum totum inponatur. Tunc funde desuper urinam recentem et sic mitte sic stare donec bene maturatum fuerit. Post hoc cola per densum panniculum in concham seu glebam crete in qua liquor urine haurietur et illud quod supersteerit usui reservas.

Si vis purgare bene lazurium, accipe ollam mundam et accipias picem nigram et tantumdem de sepo vel paulo plus et mittas liquefieri bene et tunc debes colare per panniculum densum. Et tunc accipe patellam bene purgatam et mittas in eas sepum cum pice, et tunc fundas desuper lazuris et purga cum lixivio bene calido, et hoc debes ter vel quater lixivam fundendo desuper purgare bene.

Deinde sic temperabis lazuris. Funde puram aquam super cementum et comisce; et cum clarificata fuerit, accipe de ipsa quantum sufficit et inpone in eam gummi arabicum ligatum in denso panniculo et cum dissolutum fuerit exprime et cum alia aqua temperas lazuris sic. Accipe sinigrua(?) et radas cum cultello subtili et tunc cum dicta aqua gummata comisce. Teres manu fortissime donec totaliter dissolvatur. Et tunc cum ea tempera lazuris apponens partem de zucara et purissimi mellis duas vel tres guttas secundum lazurii quantitatem. Et hec temperatura prestantior est et ab omnibus comendatur

THE PARACELSIAN COMPROMISE IN ELIZABETHAN ENGLAND

By Allen G. Debus*

When Paracelsus attacked the ancient medical authorities at Basel in 1527, and had the audacity to throw the *Canon* of Avicenna into the St. John's day bonfire, he struck a dramatic blow for a new medicine which was to embroil the physicians of Europe in controversies for the next century and a half[1]. The focal point of this struggle was the use of chemical therapy, which was considered to be the most insidious innovation by most Galenists. However, at the same time there was disagreement over the comprehensive theories of the Swiss reformer, and the history of this ideological conflict is a matter of considerable importance in the understanding of the Scientific Revolution, since, to many observers in the latter years of the 16th century, the work of Paracelsus seemed more dangerous than that of Copernicus[2].

In recent years, some studies bearing on this problem in relation to its English phase, have appeared from Georg Urdang and Paul H. Kocher[3]. These papers represent significant contributions to the history of the Paracelsians, and yet their findings leave some questions still unanswered. What, for

*History of Science, Widener 185–9, Harvard University, Cambridge 38, Mass., U.S.A. This study was completed during the tenure of a joint Social Science Research Council and Fulbright fellowship at University College, London.

[1] On the question of the burning of the *Canon* by Paracelsus, see Walter Pagel, *Paracelsus*, Basel, 1958, 20f., and Lynn Thorndike, *A History of Magic and Experimental Science*, New York, 1941, v, 438. Prof. Pagel cites Sebastian Franck's 1531 reference to the event.

[2] In John Donne's *Ignatius His Conclave*, 1610, the innovations of Paracelsus are judged to merit more reward from Satan than those of Copernicus. John Donne, *Complete Poetry and Selected Prose*, Bloomsbury, 1929, 362–9. Note also the parallel which is drawn between the work of Copernicus and Paracelsus by "R.B. esq." [? Robert Bostocke], and is discussed below.

[3] Georg Urdang, "How Chemicals entered the Official Pharmacopoeias", *Wisconsin Academy of Science, Arts and Letters, Madison*, 1949, vol. 39, 115–25, also printed in the *Archives Internationales d'histoire des Sciences*, **7**, 1954, 303–14 from which all citations will be made. Paul H. Kocher, "Paracelsan Medicine in England (*ca.* 1570–1600)", *Journal of the History of Medicine*, **2**, 1947, 451–80. Paul H. Kocher, "John Hester, Paracelsan (1576–93)", *Joseph Quincy Adams Memorial Studies* (ed. James G. McManaway, Giles E. Dawson, Edwin E. Willoughby), Washington, 1948, 621–38. Paul H. Kocher, *Science and Religion in Elizabethan England*, San Marino, Calif., 1953. See also Robert P. Multhauf, "Medical Chemistry and the Paracelsians", *Bulletin of the History of Medicine*, **28**, 1954, 101–26.

instance, was the role of the Royal College of Physicians in the introduction of Paracelsism in England? Professor Kocher states that this organization was "tough-minded, clannish, and reactionary" and decidedly against the new remedies[4]. On the other hand, Professor Urdang has shown that one-third of the members of the Pharmacopoeia committee established by the College in 1589 had graduated from those European universities which led in the promulgation of chemical therapy, and not one of them had graduated from Paris which was the chief stronghold of the most conservative Galenists[5]. His study of the proposed pharmacopoeia of 1585 would certainly indicate that the most influential medical group in England was not opposed to "Paracelsian" remedies. But what is meant by the broad term "Paracelsian"? Both Professors Urdang and Kocher are primarily interested in the introduction of chemical therapy, and since Paracelsus was considered the leader of this group in the 16th century, they apply the name to the proponents of chemical medicines[6]. Surely this is an admissible use of the word, but it is necessary to keep in mind that Paracelsian remedies were but a small part of the Paracelsian system. There was as much, if not more, disagreement over the comprehensive theories of Paracelsus, as there was over his practical reforms.

There is a need, then, to discuss the work of his followers on several levels. Those interested in the theoretical work of Paracelsus often paid little attention to his practical medical reforms. Those interested in the latter, however, were not simply limited to those who wished to utilize chemically prepared medicines, since there was at the same time a tendency to apply chemical methods to other purposes such as urinalysis, and the analysis of mineral waters.

Even a cursory glance at Sudhoff's *Versuch einer Kritik der Paracelsischen Schriften* shows that by the time of the death of the Swiss reformer in 1541, that only a small fraction of the Paracelsian corpus had been published. However, after that date his works began to be published in ever increasing numbers, and as the traditional medical men began to realize the implications of Paracelsus' attack on Galen, his commentator Avicenna, and the other ancients, they immediately began to defend their reliance on these time honoured authorities. Thus began the most momentous medical dispute of the Scientific Revolution, and because Paracelsus had demanded that alchemy should exist for the benefit of medicine alone, it was to influence profoundly

[4] Kocher, *Adams Memorial Studies*, 623. See also his discussion on page 472 of his article in the *Journal of the History of Medicine*.

[5] Urdang, *op. cit.*, 305.

[6] Prof. Kocher does distinguish between the work of Gesner and Paracelsus, and he states that Gesner was the "prime mover" of chemical medicine in England in its early stages. Kocher, *Journal of the History of Medicine*, **2**, 455.

the development of chemistry. The first comprehensive statement of the views of the Galenists seems to have been the *Disputationes de Medicina Nova Paracelsi* (4 parts, Basel, 1572–3), of Thomas Erastus, which was commissioned by the Duke of Saxony in 1572[7].

But if the physicians on the continent were already in dispute over the relative merits of the old and new medicines shortly after the middle of the century, the English were as yet untouched by this medical heresy. One of the founders of English humanism, Thomas Linacre, was not only the guiding light of the Royal College of Physicians at its inception in 1518, but he was also the enthusiastic compiler of definitive editions of the ancients. Similarly, the famous John Caius published commentaries on Galen and Hippocrates, even though he was an intimate friend of Conrad Gesner who was one of the independent German proponents of chemical remedies. Caius had lived in the same house with Vesalius while studying at Padua, and he had stopped for a time at Basel on his way back to England where he must have obtained some information on the teachings of the lately deceased Paracelsus, but there is nothing in his writings to show any acquaintance with either Vesalian anatomy or Paracelsian theory[8]. But despite this seeming lack of interest in the Paracelsian controversy on the continent, much of what was new did appear in England. Parts of the *De humani corporis fabrica* appeared within a few years after its first edition (1543) under the authorship of Thomas Geminus; and the surgical advances of Ambroise Paré were made available in England through the works of Thomas Gale and William Clowes[9].

And though the work of Paracelsus and his disciples did not yet issue from the English presses, tomes on chemical remedies and methods were available from the English book dealers. Hieronymus Brunschwig's book of distillation was "Englished" by Lawrence Andrewe in 1527, and while it combined the function of an herbal with that of a chemical text, it brought to light the view of the author that distilled remedies were far more potent than the herbs themselves[10]. Thomas Raynalde's *Compendious declaration of the vertues of a Lateli inuented oile*, Venice, 1551, was an early monograph on a chemical remedy,

[7] Karl Sudhoff, *Versuch einer Kritik der Echtheit der Paracelsischen Schriften* (2 vols., Berlin, 1894, 1899), **1**, 217.

[8] John Caius, M.D., *The Works of John Caius, M.D., Second Founder of Gonville and Caius College and Master of the College, 1559–1573. With a Memoir of his Life by John Venn, Sc.D., ed. E. S. Roberts*, Cambridge, 1912, 5ff.

[9] S. V. Larkey, *Medical Knowledge in Tudor England as Displayed in an Exhibition of Books and Manuscripts*, San Marino, Calif., 1935, 5.

[10] Hieronymus Brunschwig, *The vertuose boke of distyllacyon . . .*, tr. L. Andrewe, London, 1527.

but it is not until we reach Gesner's *Treasure of Euonymus* in 1559 that we have come to the brink of chemical therapy in England. Gesner wrote that "waters and oyles secreate by the singular industrie and wit of Chymists, are of great vertues",[11] but he explains that some physicians held them rightly in contempt because they had been incorrectly prepared[12]. Those who ascribed the introduction of this art to Brunschwig were in error, according to Gesner, and his authorities include Dioscorides, Geber, Arnold of Villanova, Ramon Lull, and John of Rupescissa, with the notable omission of Hippocrates and Galen[13]. One whole section of this recipe book is devoted to metallic concoctions. Despite this revolutionary aspect of the work, there is no indication that the author desired to overturn the time honoured medical authorities. In fact, in his few references to Paracelsus, Gesner complained bitterly that the Swiss reformer had "condemned Galen, Hippocrates and all the ancient doctors", and although "I saw a broadside printed at Basel in 1527 in which he promised that he would teach all the parts of medicine in a far different manner than it was done by the ancient doctors, . . . I heard that he accomplished nothing worthwhile, indeed, rather he was an impostor . . ."[14]. Nevertheless, he had to admit "that many were cured by him in desperate illnesses and that malignant ulcers were healed by him easily"[15].

A primary concern of the Elizabethan physicians and their Royal College was to rid the realm of the "empiricks and mechanicks", old women who sold potions to their neighbours, people who honestly believed they had a divine power of healing, and out and out quacks. These people were attacked with vigour in the *Counseill against the disease called the Sweate*, of John Caius in 1552; the *Historicall expostulation . . . against the beastly abusers, both of Chyurgerie and Phisicke in oure tyme*, of John Hall in 1565; and in the *Detection and Querimonie of the daily enormities and abuses committed in phisicke*, of John

[11] Conrad Gesner, *The treasure of Euonymus; containinge the hid secretes of nature*, tr. P. Morwyng, London, 1559, 293.

[12] *Ibid.*, 412.

[13] *Ibid.*, 421.

[14] Conrad Gesner, *Bibliotheca Universalis*, Tiguri, 1545, fol. 614. Galenum, Hippocratem, & omnes ueteres medicos contemnebat. Vidi chartã impressam Basileae, anno 1527, qua promittit se longe alio modo omnes medicinae partes edocturũ, q̃ à priscis medicis factum esset . . . sed nihil egregii eũ praestitisse audio, quin potius impostorem fuisse. . . .

[15] Thomas Erastus, *Disputationum De Medicina nova Philippi Paracelsi Pars Prima*, Basil, 1572. From the short essay titled "Conradus Gesnerus Medicus Tigurinus de Theophrasto Paracelso" appended to this work. Audio tamen multos passim ab eo in morbis desperatis curatos, & ulcera maligna ab eo feliciter sanata.

Securis in 1566[16]. There is no reason to believe that these attacks were aimed at any Paracelsians, but since these men did employ chemically prepared potions, it later became easy enough to condemn all chemical remedies simply by not distinguishing between the true spagyrists and the quacks. This distinction, already hinted at in the *Treasure of Euonymus*, was to continue to be a sore point among the Paracelsians.

The earliest references to Paracelsus by English authors occur in works dealing with mineral waters. The first of these is a tract describing the waters at Bath by William Turner, a physician and minister who was forced to flee England during the later years of Henry VIII, and again during the reign of Mary, because of his strong Calvinist leaning. While in Germany he became a friend of Gesner, and evidently at the same time learned of the interest of Paracelsus in medicinal waters. As a result he listed Paracelsus as an authority, but he did not give any personal opinion of his work[17]. This treatise was written at Basle in 1557 and printed in English at Cologne in 1562—then reprinted in 1568 and often thereafter. In 1572 John Jones (a Cambridge M.D.) wrote on the baths at Buckstones in which he referred disdainfully to the Paracelsian "fyrework of three beginnings, of salt, Brimstone, and quicksilver"[18]. Two years later he published his translation of *Galens Bookes of Elementes*. The title-page states that this is also a refutation of Paracelsian doctrine, but nowhere in the work is there any amplification of this promise[19]. He slightingly referred again to Paracelsus in his *Arte and Science of Preserving Bodie and Soule in Health* (1579), and stated that these teachings had been satisfactorily refuted in Latin by Thomas Erastus and in English by one Kinder in a work noted in the margin as *De part. hom.* Outside of this single reference there seems to be no further trace of this work of Kinder which may have been the first full-fledged attack by an Englishman on Paracelsian thought[20].

[16] John Caius, *Counseill against the Sweat* in *Works* already referred to, p. 26 (separate pagination). John Halle, *A most excellent and learned woorke of Chirurgerie . . . also against the beastlye abusers both of chyurgerie and phisicke in oure tyme*, London, 1565, iiif. John Securis, *A detection and querimonie of the daily enormities and abuses committed in Phisicke*, London, 1566, *passim*.

[17] William Turner, *A Booke of the natures and properties—as well of the bathes in England as of other bathes in Germany and Italy*, Collen, 1562, f. iii. In the same year this was also issued with the second part of William Turner's *Herball*.

[18] John Jones, *Benefit of the Auncient Bathes of Buckstones*, London, 1572, "To the Reader", fol. ii.

[19] John Jones, *Galens Bookes of Elementes . . . Confuting as well the errours of all them that went before time, as that hath, or shal folowe hereafter of the Paracelsians*, London, 1574.

[20] John Jones, *The Arte and Science of preserving Bodie and Soule in Healthe, Wisdome, and Catholicke Religion*, London, 1579, 31. See also Kocher, *Journal of the History of Medicine*, 457.

More interesting is a reference to Paracelsus made by the well-known Elizabethan surgeon, George Baker (1540–1600). In his preface to a tract which placed side by side his translations of a monograph on a Spanish chemical oil and the third book of Galen, he compared Paracelsus unfavourably with Galen and cited Erastus as his source for this. Baker's view is of considerable importance, for although he was a firm supporter of Galen and the rest of the ancients, he was at the same time one of the earliest advocates of the use of chemical therapy. As he later became an ordinary surgeon to Queen Elizabeth, and President of the College of Surgeons (1597), his views were to carry a great deal of weight. But by taking his cue from the tradition of Gesner who had no quarrel with the ancients, rather than Paracelsus who seemed to the Elizabethans to want to overturn the whole medical corpus of the past, he outlined the middle path which was eventually to prevail[21].

This moderate attitude of Baker's is again evident in *The Newe Jewell of Health* of 1576. This work was an English translation of the second part of Gesner's *Treasure of Evonymus* (1st ed. Zürich, 1569) made by Thomas Hill. Hill had intended to publish this work but he died before he had been able to do this. Sensing his death to be near, Hill had willed the manuscript to Baker who saw it through the press and added a preface in which he stated that "the vertues of medicines by Chimicall distillation are made more vailable, better, and of more efficacie than those medicines which are in use and accustomed", but on the other hand, without a knowledge of Galen and Hippocrates the reader would be at a loss to apply properly the remedies in the book[22].

Thus, by the end of the 1570's, it may be seen that the few works so far published dealing with chemically prepared medicines were done primarily under the inspiration of Conrad Gesner. With the exception of William

[21] George Baker, *The composition or making of the moste excellent and pretious Oil called Oleum Magistrale*, London, 1574; the reference to Paracelsus is from the non-paginated "To the Reader".

[22] Conrad Gesner, *The Newe Jewell of Health*, London, 1576; Preface and iii f. See also F. R. Johnson, "Thomas Hill: An Elizabethan Huxley", *Huntington Library Quarterly*, 7, 1944, 109–35. Baker's preface to the 1576 edition (the work was reissued in 1599 as *The Practise of the New and Old Phisicke—see* Plate I), is also valuable in showing that there were chemical practitioners in London at this time, to whom the physician or surgeon could turn with confidence if he should desire any of the new medicines. Baker recommended "one mayster Kemech an Englishe man dwelling in Lothburie, another mayster Geffroy, a French man dwelling in Crouched friers, men of singular knowledge that waye, another named John Hester dwelling on Powle's wharfe, the which is a paynfull traveyler in those matters, as I by proofe have seene and used of their medicines to the furtheraunce of my Pacients healthes." Gesner, *Newe Jewell*, iv f. Little is known of Kemech or Geffroy, but Hester's work will be considered later.

The practise of the new and old phisicke,

wherein is contained the most excellent Secrets of Phisicke and Philosophie, deuided into foure Bookes. In the which are the best approued remedies for the diseases as well inward as outward of all the parts of mans body: treating very amplie of all distillations of waters, of oyles, balmes, Quintessences, with the extraction or artificiall saltes, the vse and preparation of Antimony, and potable Gold Gathered out of the best & most approued Authors, by that excellent Doctor *Quercetan*. Also the Pictures and maner to make the Vessels, Furnaces, and other Instruments thereunto belonging. Newly corrected and published in English, by *George Baker*, one of the Queenes Maiesties chiefe Chirurgians in ordinary.

Printed at London, by Peter Short. 1599.

PLATE I.

THE
difference betwene the aun
cient Phiſicke, firſt taught by the goa
ly forefathers, conſiſting in vnitie peace ane
concord: and the latter Phiſicke proceeding from Idolaters, Ethnickes, and Heathen: as *Gallen*, and ſuch other conſiſting in dualitie, diſcorde, and contrarietie.

And wherein the naturall Philoſophie of *Ariſtotle* doth differ from the trueth of Gods worde, and is iniurious to Chriſtianitie and ſounde doctrine.

Natura naturam continet & ſuperat, & ſua natura ſolùm lætatur & emendatur, & eius propinquitatis res commiſceri & coniungi facit.

By *R. B.* Eſquire.

Imprinted at London
for Robert VValley.
1585.

Turner's non-committal reference, the citations of Paracelsus had all been of universal distrust, and the reason for this is probably that the chief references to him come from John Jones and George Baker—both of whom seem to have become acquainted with Paracelsus' work through the refutation of it made by Erastus in 1572–4.

It was not until 1585 that any Englishman took notice of the comprehensive Paracelsian theories. At that time one R.B. esquire (possibly R. Bostocke—see footnote 23) wrote his *Difference betwene the auncient Phisicke . . . and the latter Phisicke*[23]. The author of this work was interested in the theory of Paracelsus rather than in the application of the new chemical remedies. (*See* reproduction of title-page on Plate II.)

Bostocke relates that one of the reasons he wrote the book was that

> I was the last Parliament time before this that is now sommoned at the table of a reverend Bishoppe of this land, which was not unskilful in Physicke, in the companie of a Phisition, which inveying against this auncient Phisicke, by the name of Paracelsus his Phisicke, ignorantly attributing to him the first invention thereof, pleased himself and some of his audience in telling that the same Phisicke had no ground nor foundation, neither any being[24].

This, then, was a new approach in terminology. George Baker, and John Hester (whose work will be considered later), had pointed out that the new chemical remedies had in reality an earlier origin than the early years of the current century, but nevertheless, they had still considered this as the new "phisicke" in contrast to the old "phisicke" of Galen. Bostocke, on the other hand, considered it his primary aim to point out that iatrochemistry was actually the ancient medicine which had steadily deteriorated after the Fall of man until it had reached the depraved state in which Galen offered it. The original chemical physicians were to be sought in a line of sages that ran from

[23] This work of some ninety-six unnumbered leaves was attributed to R. Bostocke, esq., by Andrew Maunsell in his *The Seconde parte of the Catalogue of English printed Bookes*, London, 1595, 4. In the *Short Title Catalogue* by Pollard and Redgrave it was also attributed to Bostocke and while this identification cannot be taken as proven, the early Maunsell reference would lead one to believe that the author of this treatise was actually this otherwise unknown Bostocke. There was a Robert Bostock who was a London printer active in the second quarter of the 17th century. While this long interval in time from the publication of the book to his active participation in the trade makes this identification doubtful, the connexion cannot be entirely ruled out as an R. Bostock was listed as an apprentice in London in the 1580's.

[24] R.B., Esq., *The difference betwene the auncient Phisicke . . . and the latter Phisicke*, London, 1585, Chap. 7. This work is not paginated, and hence references will be made either to chapter numbers or prefatory material.

Adam through the sons of Seth, Abraham, Moses, Hermes Trismegistus, Thales, Democritus, Pythagoras, and even Hippocrates. Untold secrets were to be discovered in the myths of the ages, but by the time of Plato and Aristotle all this was changing. Bostocke equated Plato's contempt of Greek physicians with their lack of chemical knowledge, and Aristotle is treated with even more scorn than Galen[25].

> The heathnish Phisicke of Galen doth depende uppon that heathnish Philosophie of Aristotle, (for where the Philosopher endeth, there beginneth the Phisition) therefore is that Phisicke as false and iniurious to thine honour and glory, as is the Philosophie[26].

Thus it is on religious grounds that he rejects Aristotle and Galen when he speaks of "The heathnish Philosophy of Aristotle, which admitteth nothing, that cannot be demonstrated"[27]. Continuing his historical treatment he grants merit to only the Alexandrian alchemists, the Arabian adepts and a handful of Western chemists and alchemists of the late middle ages such as George Ripley in the period up to the 16th century.

Hence, to Bostocke, the reform of Paracelsus was just a matter of purification of medicine, much as his age saw the restoration of other fields of discipline to their pristine purity. He explains that Paracelsus

> was not the author and inventour of this arte as the followers of the Ethnikes phisicke doe imagine, as by the former writers may appeare, no more than Wicklife, Luther, Oecolampadius, Swinglius, Calvin &c. were the Author and inventors of the Gospell and religion in Christes Church, when they restored it to his puritie, according to Gods word, and disclosed, opened and expelled the Clowdes of the Romish religion, which long time had shadowed and darkened the trueth of the worde of God. And no more then Nicholaus Copernicus, which lived at the time of this Paracelsus, and restored to us the place of the starres according to the trueth, as experience and true observation doth teach is to be called the author and inventor of the motions of the stars, which long before were taught by Ptolmeus Rules Astronomicall, and Tables for Motions and Places of the starres by long excesse of time grewe to be unperfect (which imperfections by Copernicus his observations were disclosed, opened and brought to their former puritie[28].

The Copernican reference is an early and interesting English notice of the astronomical system, however, it should be explained that Bostocke did not use the heliocentric system himself, but considered the Copernican work only to be a restoration of the Ptolemaic star tables.

[25] See R.B.'s historical sections, *ibid.*, Chaps. 10–19.
[26] *Ibid.*, The Authors obtestation to almightie God.
[27] *Ibid.*, The Authors obtestation to almightie God.
[28] *Ibid.*, Chap. 19.

The religious aspects of the Paracelsian system are of paramount importance to R.B., and as the heavenly virtues of chemical remedies are compared with the true doctrine of Christ, so the "corporall and Grosse medicines" of Galen and the common doctor may be likened to the Romish religion which

> is mixed with impurities, and standeth in outward ceremonies and traditions, corporal exercises, which be less to the workes of the spirite, whylest it is occupied about them[29].

But if

> The Chymicall Phisition in his Phisicke first and principally respecteth the worde of God, and acknowledgeth it to be his gifte, next he is ruled by experience, that is to say, by the knowledge of the three sustanties, whereof eche thing in the great world and man also consisteth, that is to say, by their severall Sal, Sulphur and Mercury, and by their several properties, vertues, and natures, by palpable and visible experience. And when he knoweth the three substanties and all their properties in the great world, then after shall he knowe them in man. For man is Microcosmus for this cause, that hee might have the good and bad sicknesse and health of the great world[30].

From this it is evident that Bostocke thoroughly accepted the time honoured concept of the macrocosm and the microcosm which was a fundamental part of Paracelsian theory. Also of basic importance was the use of the three principles and the discarding of the traditional humoral system. He explained that

> Humors and qualities, to the which the folowers of the Ethnikes doe so much cleaue, and in the which they spende their study and labour, are but onely dead accidents, without power of lyfe. They be conditions, signes, tokens, and as it were onely flowers and colours of diseases and not the very matter, cause, substance, or nature of the disease, they are caused and not the causes . . .[31] (However) ech member hath his proper humour not like to any of the fower, but according to the cõstitution of the members, and their effect, eche member possesseth his own humour[32].

While Paracelsus had elaborated on a system of five basic diseases in his *Volumen Paramirum*[33], Bostocke preferred a variant theory based more rigidly on the three principles.

[29] *Ibid.*, Chap. 6.

[30] *Ibid.*, Chap. 8, section 5.

[31] *Ibid.*, Chap. 5.

[32] *Ibid.*, Chap. 8, section 8.

[33] Henry M. Pachter, *Paracelsus*, New York, 1951, 133–4.

> Therefore there be three generall kinds of diseases, and eche of them haue their especiall sortes of infirmities, as there be sundry sorts of Sal, Sulphur and Mercuri of diuers and sundry natures. There be likewise three kinds of medicine required, and eche kinde of sondry nature to preserve or restore mans body to health[34].

Diseases were to be cured with a knowledge of the Paracelsian Arcana, and a unitary rather than a dualistic method was to be employed. In other words, a disease contracted in a lead mine could be cured with a remedy prepared from lead. The dualistic method of the Galenists would prefer a medicine prepared from a substance opposite to that which caused the disease[35].

The new medicine was incorporating a new system of nomenclature to replace the senseless names of diseases employed by the Galenists. Here an attempt was to be made to name the disease on the basis of the principle that was its cause[36]. "Anatomy" also was not to be considered in the manner which we use the word today, but rather

> he that will be a perfect Phisition, must know eche disease by his right Anatomie, that is to say, by the matter, property and nature of the true substaunce of the disease, as which of the three substaunces have broken unitie, and not by the signe of it. . . . For the right Anatomy consisteth not in cutting of the body, but in the knowledge of the Amitie, concord and nature of all naturall externe things, with man, which doe agree, imbrace and receave eche other, and concord together in mutual agreement, in vertue, power, propertie and essence, to defend nature[37].

And again, the chemical surgeon avoids the knife and instead works with "oyles and Balmes to pacifie nature, and to keep the wounde defended from accidents, and to leave the cure to nature which is able then to be its own surgeon"[38].

In regard to the relation of chemistry to medicine, Bostocke is unequivocal, for at the opening of the volume he states that

> The true and auncient phisicke which consisteth in the searching out of the Fountaines of Nature, and is collected out of Mathematicall and supernaturall precepts, the exercise whereof is Mechanicall, & to be accomplished with labor, is part of Cabala, and is called by auncient name Ars sacra, or magna, & sacra scientia, or Chymia, or Chemeia, or Alchimia, & mystica & by some of late Spagirica ars[39].

[34] R.B., *op. cit.*, Chap. 4.

[35] *Ibid.*, Chap. 1.

[36] *Ibid.*, Chap. 8, section 14.

[37] *Ibid.*, Chap. 4.

[38] *Ibid.*, Chap. 11.

[39] R.B., *op. cit.*, Chap. 1.

And although he stated that "the Chymicall Philosopher layeth the foundation of his Philosophie in Gods booke"[40], he was well aware that according to Paracelsus the creation could be interpreted as nothing but a divine chemical separation[41].

But those who thought they might make gold by this process were greatly deceived, for the alchemists were really discussing the preparation of medicines which would cure all bodily ills and not secret recipes for the transmutation of the base metals as it appeared on the surface. The occult language of these ancient alchemists was explained by Bostocke—

> because Secretes are to be reveyled onely to the Godly, and unto the children of doctrine and knowledge, and unto the wise, therefore they did write unto such, that the secrets might be hidden from the ungodly, foolish, slouthful and unthankfull hypocrites, whereby the wise and diligent with travayle and labour might attaine to the understanding thereof, as one of them sayde, it is not meete to provide for a man a Pigion and to rost it for him and also to put it unto his mouth or chawe it for him[42].

Fully aware that the Paracelsists were being castigated on the continent for their use of strong inorganic compounds as medicines, he laid strong emphasis upon the purification of the chemical remedies and their use in small quantities[43]. Furthermore, he contrasted the chemical physician who carefully extracted the essence of metals through means of his art with the traditionalist who used

> Golde, and steale in Drink or Brothe, . . . (and gave) . . . Golde beaten into fine leaves in medicine, and . . . (used) . . . pearls and Precious stones (which be Mynerals also) in power (which is their body) for medicine and sometimes the very bodies of some Mettals: which is contrary to the rules of this auncient Chymycall Phisicke, and thinke they doe much good therewith[44].

But those who complained that the Spagyrists only dealt with mineral remedies were in the wrong, for Bostocke pointed out that herbs and plants formed a valuable part of the physicians' cures, just as long as they were treated chemically before administering them to the patient[45]. The chemical physician

[40] *Ibid.*, Chap. 8.
[41] *Ibid.*, Chap. 21.
[42] *Ibid.*, Chap. 3.
[43] *Ibid.*, Chap. 8, section 15.
[44] *Ibid.*, Chap. 8, section 12.
[45] *Ibid.*, Chap. 9.

is also warned not to experiment on men, but rather, he should learn the cause of the disease through the macrocosm and then apply it to his patient. This again was one of the chief points of attack on the Paracelsists on the continent, and Bostocke stated the matter in these words:

> So in ministering of medicines, he willeth them not to minister, before they know the cause and nature of the disease, & what & how much it wanteth of his proper nature, and what and how much it hath gotten of an other nature. For incognita causa, a casu procedit cura, to the knowledge whereof wee ought to come, as the Alkimistes doe come to the knowledge of the body that is to them unknowne, and not by trying of the medicine in man[46].

Finally, Bostocke took up certain objections which had been specifically raised to Paracelsus and his works. This was necessary, for beyond the appeal first to holy scripture and then to personal experience, he suggested that the physician who

> listeth to leane to Bookes . . . (should) . . . learne of those Bookes which Paracelsus hath most Godly and learnedly expressed in his Labyrinth. In comparison of which al other Aucthorities in those matters are small or none[47].

Thus Erastus had accused him of "Heresie, conjurations, lacke of learning, as also hurt and danger of mynerall medicines and obscuritie of writing"[48]. The reasons for the obscurity and the true explanation of mineral remedies have already been dealt with, and as for the connection with the magical arts,

> Paracelsus excludeth from the true, pure, and auncient Magicke, and from his coelestiall medicine, all Nigromancie, Sorcery, Ceremonies, Coniurations, and all maner of invocations of devilles, Demones & evill spirits: And he giveth an especiall charge that this Arte be onely used to doe good, and not to the prejudice nor hurt of any bodie and that it be done without Ceremonies, Coniurations, invocations, Consecrations, Blessinges, and all maner superstytion whereby it becometh ungodly[49].

This is a not unusual defence of natural magic.

To those who complained that the works of Paracelsus lacked any logical method, Bostocke replied that this was a lie in most cases, but that a lack of method was intentional in some other cases in which the great master had planned to withhold his choicest secrets only for the initiated[50]. And to those

[46] *Ibid.*, Chap. 8, section 19.
[47] *Ibid.*, Chap. 8, section 6.
[48] *Ibid.*, Chap. 20.
[49] *Ibid.*, Chap. 24.
[50] *Ibid.*, Chap. 24.

who complained that Paracelsus wrote only in German and knew no Latin, he answered that this too was an untruth as some of his works were in Latin[51]. Although all other objections could be swept away, Paracelsus' reputation as a drunkard remained to trouble Bostocke's essentially Puritan mind. Compromising by attributing this fault less to the man than to the habit of his country, he suggested that "the doctrine bee tried by the worke and successe, not by their faultes in their lives"[52].

And in a bid for a revision of the medical curriculum in the universities he complained that

> in the scholes nothing may be received nor allowed that savoreth not of Aristotle, Gallen, Avicen, and other Ethnikes, whereby the yong beginners are either not acquainted with this doctrine, or els it is brought into hatred with them . . . likewise the Galenists be so armed and defended by the protection, priviledges and authoritie of Princes, that nothing can be allowed that they disalowe, and nothing may bee received that agreeth not with their pleasures and doctrine[53].

He concludes that if it were lawful for men to study both sides of the question, the Paracelsian doctrines would triumph.

Bostocke was the only English author in the 16th century who was more interested in Paracelsian theory than its practice. Others might use Paracelsian backing for the introduction of chemical remedies, but even here the trend was more to seek precedent in the recipe books of Gesner and Fioravanti such as George Baker, and later John Hester, edited. But with Bostocke we find a small compendium of Paracelsian doctrine much as the Swiss reformer originally presented it, a mixture of grandiose theory and valuable reform.

However, there is no indication that anyone was impressed or even interested in his work. In the following year (1586) Bostocke's work was referred to by the equally unknown I.W. in a short defence of chemical medicines. This work too is an apology for the Paracelsists, but on a much lower level. I.W. states that his only desire is to convert the reader to the Paracelsian medical preparations and he implies that a discussion of the deeper aspects of their theory and their relation to the macrocosm and the microcosm will be offered in the author's forthcoming *Anatomy of Death*. I have been unable to find any reference to the existence of this latter work. He passes over the question of the antiquity of the "new sect" and merely refers the reader to the recent work of "Master B." He insists on the need of chemistry to separate the pure from the gross parts

[51] *Ibid.*, Chap. 24.
[52] *Ibid.*, Chap. 24.
[53] *Ibid.*, Chap. 9.

of the medicines and explains that the Galenic remedies often cause harmful results because the impure parts of the medicine gain control of the body. In his defence of Paracelsus he shows that he did write in Latin as well as German, and in regard to his supposed heresy and conjury he refers the reader to his *De occulta Philosophia* and *De Magia*. The excessive drinking of his idol remained to trouble him and he decided that he had to spend so much time at his hot furnaces distilling and subliming that he had to drink to cool off. Many pages of this tract deal with a discussion of specific remedies, but the author's failure to discuss Paracelsian theory in detail is to be regretted[54].

There were no other treatises of English authorship devoted to Paracelsian theory in the 16th century except the work of Thomas Moffett which will be mentioned later. Early in the next century, several works on mystical alchemy and iatrochemical theory were written by Thomas Tymme and Timothy Willis, and there were as well the voluminous writings of Robert Fludd, but these were all without exception ignored in England. Fludd alone gained recognition for his work, but only in Germany[55]. There was little interest in England in mystical or occult works in medicine or alchemy in the 16th century or even well into the 17th century.

Although works dealing primarily with Paracelsian theory found little popularity until the mid-17th century in England, treatises devoted to the promotion of chemical medicines continued to be published in ever increasing numbers. The man chiefly responsible for this was a distiller by the name of John Hester whose shop was on Paul's Wharf in London. George Baker referred to him as a reputable purveyor of the new medicines in his preface to the *Newe Jewell*[56], and as Thomas Hill had bequeathed to Baker the manuscript of that work, so too he had bequeathed to Hester the manuscript of a second work. This was a translation from the Italian chemical physician, Leonardo Fioravanti, titled *A Ioyfull Iewell* (1579). From then until his death (*c.* 1593) Hester continued to pour out a flood of translations. First he decided to concentrate on

[54] I.W., *The copie of a letter sent by a learned Physician to his friend, wherein are detected the manifold errors used hitherto of the Apothecaries*, London, 1586. This short tract is composed of some 15–20 leaves and is non-paginated.

[55] The works of Robert Fludd are too numerous to be mentioned here. Other early 17th-century works of English authorship include the following: Thomas Tymme, *A Dialogue Philosophicall*, London, 1612. Tymme's views are also set forth in his preface to his translation of Joseph Duchesne's *The Practise of Chymicall, and Hermeticall Physicke, for the preseruation of health*, London, 1605. Timothy Willis wrote two alchemical works, the *Praepositiones Tentationum*, London, 1615; and *The Search for Causes*, London, 1616. Finally it might be mentioned that the bishop of Worcester, John Thornborough, composed an alchemical tract, the Λιθοθεωρικός, London, 1621.

[56] See footnote 22.

Fioravanti's works and later he turned to other authors such as DuChesne, Hermann, spurious works by Paracelsus and others.

Relatively uninterested in the deeper aspects of Paracelsism, he normally chose works to translate which were short on theory and long on lists of recipes. As long as the tracts had these recipe collections attached to them he cared little what other theoretical views they put forth. Actually his authors agreed on little more than two specific points in medical reform; the importance of chemical remedies and the need for experimentation. But aside from this, his translations put forth all sides of the views being expressed at that time by the continental spagyrists. For instance, Duchesne praised both Paracelsus and Galen[57] while Fioravanti praised hardly anyone but himself[58]. Another author, G. A. Portu Aquitans, in his preface to the *Hundred and Fourteen Experiments of Paracelsus* showed the bitter hatred of some continental Paracelsians for the Galenists[59]. As Hester was no theorist, he made no mention of the three principles of Paracelsus himself, and his prefaces note no alarm when Duchesne and Fioravanti continue to use the old system of the four elements and their corresponding humours. Duchesne had worked out an independent system in regard to the interrelation of the elements and the principles which was to be offered to English readers in a translation by Thomas Tymme in 1605, but there was no hint of this theory in Hester's translations[60].

In his bid for the new medicines, Hester particularly stressed the fact that there were now new diseases which the ancient medicine had no cure for—and the most notorious of these were the venereal diseases[61]. Here his translations stressed the use of guaiac wood (actually opposed by Paracelsus) and mercury compounds.

[57] Josephus Quercetanus (Duchesne), *A Breefe Aunswere of Joseph Quercetanus . . . to the exposition of Iacobus Aubertus Vindonis, concerning the original, and causes of Metalles, set forth against the Chimists*, tr. John Hester, London, 1591, 2, 4.

[58] Leonardo Phioravanti, *A Short Discourse uppon Chirurgerie*, tr. John Hester, London, 1580, Aiv. On Fioravanti's very few references to the "divino" Paracelsus see Davide Giordano, *Leonardo Fioravanti Bolognese*, Bologna, 1919, 14, note 1.

[59] Leonardo Phioravant, *Three Exact Pieces* (including) *One Hundred and Fourteen Experiments and Cures of the Famous Physition Theophrastus Paracelsus. Whereunto is added certain excellent Works by B.G. (Londrada) A. Portu Aquitans . . .*, tr. John Hester, London, 1652; Preface.

[60] Josephus Quercetanus (Duchesne), *The Practise of Chymicall, and Hermeticall Physicke*, tr. Thomas Tymme, London, 1605. For an excellent modern appraisal of Duchesne's views on the principles and elements see R. Hooykaas, "Die Elementenlehre der iatrochemiker", *Janus*, **41**, 1937, 1–28.

[61] Phillippus Hermanus, *An excellent Treatise teaching howe to cure the French-Pockes . . . Drawen out of the Bookes of that learned Doctor and Prince of Phisitions, Theophrastus Paracelsus*, tr. John Hester, London, 1590; Preface.

Although he denied the possibility of transmutation and insisted that the purpose of alchemy was to serve as a handmaiden to medicine[62], he had no qualms about offering Duchesne's twelve steps leading to transmutation to the reader[63]. Hester's occasional references to theoretical problems are often contradictory since they are from other authors and he certainly did not consider them the most important part of his translations. His emphasis was always placed on the actual compositions, and he usually closed each work with a notation that any of the remedies could be purchased "at Paule's Wharfe, by one John Hester practisioner in the Art of distillation, at the signe of the Furnaises"[64].

No other apothecaries or distillers were as vocal in their praise of chemistry as Hester, but the early and non-controversial acceptance of chemical remedies may be seen in the works of the English surgeons and physicians[65]. George Baker, president of the College of Surgeons in 1597, had been one of the first to promote such remedies in the 1570's, and although he had no love for Paracelsus, many of his colleagues borrowed freely from the specifically Paracelsian remedies. One of the most notable instances of this is the *Antidotarie* of the famous English surgeon John Banister (1589). In this collection of cures for various wounds, Banister cited Paracelsus and his disciples Duchesne and Thurneisser no less than thirty-five times[66].

William Clowes was another noted Elizabethan surgeon. In a work published by him in 1579, he lashed out against empirics of all sorts, but he did not make any reference to Paracelsus or the Paracelsians[67]. Only a few years

[62] John Hester (tr.), *The Secrets of Physick and Philosophy . . . First written in the German Tongue by . . . Theophrastus Paracelsus and now published in the English Tongue by John Hester, Practitioner in the Art of Distillation*, London, 1633, 107.

[63] Quercetanus, *Breefe Aunswere*, fols. 17f.

[64] Hester (tr.), *Secrets of Physick*, from the non-paginated "to the Reader".

[65] Prof. Kocher has followed in considerable detail the references to Paracelsian remedies in the works of the main surgical authors of this period, Clowes, Banister, Baker, etc., and he has shown that there was a gradual acceptance of chemical therapy by all of these men whom he calls "the most enterprising and enlightened group of surgeons, or indeed, medical practicioners of any kind in England at that time" (Kocher, *Journal of the History of Medicine*, 458). This reconciliation of the English surgeons with chemical remedies eventually led them to even look on Paracelsus kindly, but none of them ever pretended to understand deeper Paracelsian thought. See Kocher, *Journal of the History of Medicine*, 466–80 *passim*.

[66] For a fuller description of this work see Kocher, *Journal of the History of Medicine*, 466–7. For specific references to Paracelsus see John Banester, *An Antidotarie Chyrurgicall*, London, 1589; 20, 97–9, 103, 107, 135, 136, 296–9.

[67] William Clowes, *A Short and profitable Treatise touching the cure of the disease called Morbus Gallicus by Unctions*, London, 1579; Cir.

later when he first took notice of the works of Paracelsus in his writings he was most careful to distinguish between the "proud prattling Paracelsian" and "the good workes of the right Paracelsian"[68]. In his last published work (1602), he complained that although he could not understand the theories of the Paracelsians, that he found many of their plasters, balms and distilled waters of great surgical value. He wrote that

> if I finde (eyther by reason or experience) any thing that may be to the good of the Patients, and better increase of my knowledge & skil in the Arte of Chirurgery, be it eyther in Galen or Paracelsus; yea, Turke, Ieue, or any other Infidell: I will not refuse it, but be thankfull to God for the same[69].

One might hardly expect that there would have been any real enthusiasm for the chemical remedies among the members of the Royal College of Physicians, since most of these men had been brought up in the traditional training based on the ancients, but here, too, a surprising moderation is evident. In 1585 the members proposed to publish an official Pharmacopoeia, and one of the sections of the work was to be devoted to chemical medicines. Although this work was never printed, it is interesting that four years later separate committees were set up to prepare the various sections[70]. Among the three physicians put in charge of the section on chemical medicines was Thomas Moffett, whose opinions on chemistry had been aired by him in a tract entitled *De Jure et Praestantia Chemicorum Medicamentorum* (1584). Thomas Moffett (1553–1604) had studied under John Caius and Thomas Lorkin at Caius College, and then went abroad where he studied medicine under Felix Plater and Zwinger at Basel, and obtained his M.D. in 1578. During these years when he studied at Basel, and in the following four years when he travelled through Italy and Germany, he adopted the Paracelsian system of medicine. On his return to England in 1582 he received an M.D. at Cambridge, and in the Summer of that year he journeyed to Denmark where he became acquainted with Peter Severinus and Tycho Brahe. He became a candidate of the Royal College of Physicians in December, 1585, and was elected a fellow and censor of that organization in 1588. He was a man who moved in the highest court circles, and among his friends and patients were numbered such Elizabethan worthies as Sir Francis Drake, Sir Francis Walsingham, and the Earl of Essex[71].

[68] William Clowes, *op. cit.*, 1585 edition, fol. 59.

[69] William Clowes, *A Right Frutefull and Approoved Treatise for the Artificiall Cure of that Malady called in Latin Struma*, London, 1602; Epistle to the Reader.

[70] *Pharmacopoeia Londinensis . . . with a Historical Introduction by George Urdang*, Madison, 1944, 11.

[71] Sidney Lee: "Thomas Moffett", *Dictionary of National Biography* (1949–50 edition), vol. 13, 548–50.

Although Moffett was a Paracelsian, it was not in the highly partisan sense of the word. In the course of his broad medical training he had learned to appreciate the works of the ancient Greek physicians to a somewhat greater extent than had R.B., but here again we may note one of the hallmarks of Paracelsism—if any of the Greek physicians should be studied, it should be Hippocrates and not Galen. Consequently, we find that Moffett published a digest entitled *Nosomantica Hippocrates Prognostica* (Frankfort, 1588). He also collected a work on entomology (largely from a manuscript started by Wotton, Gesner and Pennius in the 1550's) which was not published until thirty years after his death by his Paracelsian successor, Theodore Turquet de Mayerne[72]. He is credited with several other works, but the one which concerns us here is his *De Jure et Praestantia Chemicorum Medicamentorum* which was completed in 1584 in London, and published first at Frankfort in the same year. Although no English edition appears to have been printed, it seems to have been fairly popular on the continent where it was reprinted at Nassau in 1602, and then included in the first volume of Zetzner's *Theatrum Chemicum* of 1613 which was reprinted in 1659.

This tract, which comprises only forty-four pages in the 1659 edition, is composed of some prefatory remarks, a dialogue between two physicians identified only as Philerastus (Phil-Erastus) and Chemista, and five appended letters dealing with various aspects of the new medicine. The work concentrates on the defence of chemical remedies, but the author's knowledge of Paracelsian dogma is evident throughout. Evidently inspired to write it after his trip to Denmark, he dedicated it to his new-found friend Peter Severinus, the chief physician to King Frederick of Denmark and one of the most important of the continental Paracelsians. In the dedicatory letter he also sent his regards to Tycho Brahe.

He begins by admitting that

> Many are beginning to hold chemistry in such distaste that they are horrified by the very name itself, . . . while others praise chemical remedies loudly, but so often by their own negligence has Vulcan permitted faults, that they must call forth the art anew or dishonour the demonstrator[73].

[72] Thomas Moffett, *Insectorum sive Minimorum Animalium Theatrum . . . ad vivum expressis iconibus super quingentis illustratum*, London, 1634.

[73] Thomas Moffett, "De Jure et Praestantia Chemicorum Medicamentorum", *Theatrum Chemicum* ed. L. Zetzner (Argentorati, 1659), 1, 64 f. Nam illorum plurimi Chemiam tanto odio habere coeperunt, ut ipsius solo nomine audito inhorrescant. . . . Alii vero Chemica vehementer laudant remedia: sed quoties sua ipsorum negligentia Vulcanus vitium admisit toties artem denuo lacessunt, vel traducunt demonstratorem.

Indeed, in the dialogue, Philerastus complains that the rumour has reached him that "chemical remedies are by far the most dangerous, and that various illnesses have been carried to excessive violence in applying them"[74]. Chemista replies by way of an explanation of where chemical remedies are being used and by whom. He cites the ancients, the Arabs and the men of his own day, among whom he singles out "that upright Gesner of blessed memory". After this imposing list of authorities, he speaks in awe of their "golden preparations of metals and minerals" and concludes that

> if you wish to stand your ground on the judgment of the ancients or of the more recent writers, it would have to be conceded the mineral and metallic remedies not only should merit their place with the doctors, but that they should even be preferred in many internal disorders[75].

In regard to the relation of the heavenly bodies to earthly ones, Moffett is uncompromising, for when Philerastus wants to know what the Zodiac is, Chemista replies that

> the signs of animals are not preserved for those phantasms of the astrologers, but rather for true and vital matters; for I believe that there is a double life in animals; one of which is in them themselves, the other which operates in us; and when the first passes away, the second gains control; and the remedy of death offers nourishment for an alteration of the body[76].

Indeed, all earthly matter is connected with the divine beings,

> For in truth there is as much virtue in us as there is God in us, as much wickedness as there is the devil; as much reason as there is the angels; as much motion and sense of choice as there is in us the brutes; as much growth as there is of plants; and there is as much salt, sulphur and mercury as there is of mineral matter.[77]

[74] *Ibid.*, 82. Etenim ad nostras aures rumor non ἀδήσποτος pervenit, chemica remedia esse omnium longe periculosissima, variosque aegrotos prae nimia sua in agendo violentia abstulisse. . . .

[75] *Ibid.*, 83. Ita ut sive veterum judicio, sive recentiorum suffragio stare velis; Mineralia & metallica remedia non solum locum suum mereri apud medicos concessurus es, sed debere etiam in multis internis affectibus cunctis medicamentis praeferri.

[76] *Ibid.*, 76. PH. . . . sed quam ob rem vocas Zodiacum? CH. Quia hic animalium signaturae non illae imaginariae Astrologorum, sed verae & vitales servantur; volo enim duplicem inesse vitam animalibus; unam quae in se ipsis, alteram quae in nobis operatur; prima evanescente, secunda obtinet imperium: necisque vel medicamentum praebet ad corporis alterationem alimentum.

[77] *Ibid.*, 65. Nam revera quantum in nobis virtutis habitat, tantum Dei inest: quantum sceleris, tantum diaboli: quantum rationis, tantum Angelorum: quantum motus sensusque arbitrarii tantum bruti: quantum auctionis, tantum plantae: quantum salis, sulphuris, mercurii, tantum mineralium.

The Paracelsian three principles play a prominent role in Moffett's tract, and he appeals for their acceptance not through blind belief, but rather through experiment, for

> Henceforth let us say that the body of man consists of sulphur, mercury, and salt alone, not because we know this as perfectly as Adam, but because the resolution of all kinds of natural as well as artificial bodies shows it to be so[78].

The theory of the principles is gone into in far more detail when Moffett avers that:

> Paracelsus and other well-known chemists, who have drawn so much light from God, have shown that the principal matter of man has come forth from the earth where it was concealed; for they have dissected its veins with continual and enormous labour, they have opened the viscera, they have broken the bones, they have dissolved the marrow, indeed, they have not moved a stone without at that very place examining it. At length, with the benefit of Pyrotechny and Alchemy, and by their long and almost Herculean labours, they have found nothing simple in the earth except the vaporous, the inflammable, and the fixed: nothing mixed which was not composed out of the same simples. On which account they are resolved that man also is of a doubly principled nature, the one being volatile, and the other fixed. The volatile in turn has a duplex nature: the first vaporous, which is called mercury, the second inflammable, which has obtained the name of sulphur. Mercury is the vaporous principle of the body: by itself a boundless, humid, liquid vehicle of natural balsam: sulphur with salt is like incorporating water with sand to a calx. Sulphur is the inflammable principle of a body, fatty, light, uniform, a fomentation of vital balsam. Salt truly is the fixed principle of a body, weighty, solid, and uniting the greatest strength, yielding neither to iron nor fire[79].

[78] *Ibid.*, 100. Hinc dicimus hominis corpus ex solo sulphure, Mercurio atque sale constare: non quia tam perfecte id noscimus atque Adamus, sed quia tam naturalis quam artificiosa corporum omnigenorum resolutio, rem ita se habere ostendit. For a similar passage see also *Ibid.*, 95.

[79] *Ibid.*, 101. Paracelsus contra aliique insignes Chemici, cum a Deo tantum luminis hausissent, materialia hominis principia in terra unde provenerat abscondi: continuo atque improbo labore venas ejus dissecuerunt, viscera apuerunt, ossa fregerunt, medullam colliquarunt, nullum non lapidem moverunt, ut quae illic habentur corpora diligenter examinarent. Tandem vero Pyrotechniae Alchemiaeque beneficio, longisque suis & plus quam Herculeis laboribus, nihil simplex in terra deprehenderunt, praeter vaporosum, inflammabile, fixum: nihil mixtum, quod non ex iisdem simplicibus componeretur. Quare hominis quoque principium duplex esse constituunt, alterum volatile, alterum vero fixum. Volatile vicissim duplex est: primum vaporosum, quod Mercurius dicitur, secundum inflammabile, quod sulphuris nomen obtinuit. Mercurius est corporis principium vaporosum: per se ipsum interminabile, humidum, liquidum, naturalis balsami vehiculum: sulphur cum sale, ceu aqua cum arena calcem incorporans. Sulphur est corporis principium inflammabile, pingue, leve, aequale, vitalis balsami fomentum. Sal vero est fixum corporis principium, pondus, solidatatem, roburque maximum concilians, neque ferro neque igni cedens per se.

At the end of this dialogue Philerastus admitted his defeat and Chemista christened him Philalethes. The final part of the tract consists of five letters from Chemista, four of which are to his disciple Philalethes the German in which he takes up various aspects of the new medicine in somewhat more detail. The one of most interest to us is the letter to Philalethes dated from London on the 4th Cal. of February, 1583, in which he refers to a letter from his imaginary (?) friend complaining about the arguments which were being raised against him by a certain Galenist and his cronies. He is asked for help in replying to these charges, and he is glad to be helpful. As this letter includes specific attacks on Paracelsus it is perhaps worth while to quote it at some length. He begins by quoting Philalethes' antagonist to the effect that

> "Chemists depart completely from the authority of the medical fathers:" but I say that if they should do this in some things, I judge it to be a fair charge: but if truly in all things (as he imagines perfidiously) I consider it to be very unfair. . . .
>
> And he says that chemists are ignorant of all the more refined remedies: that they have not chosen from the Greek authors, that they have scarcely respected the Arabs, but that they have chosen from Paracelsus alone, a drunkard, magician, impostor, beggar, market attender, worker of the hidden arts of heaven and earth, in short, a man hated to the learned . . . I call forth that braggart (the least of all the chemists) into their own arena, and I should fear not at all to debate with him on the subject of the Greeks or Arabs . . . in regard to the faults of Paracelsus . . . Natural cabala, pyrotechny, the exaltation of medicines, the contemplation of physical matters, miraculous invention, the singular ingenuity of Paracelsus; these things delight, captivate, allure and attract chemists; non-natural magic, drunkenness, abusive language, contempt of method, all these things are repudiated by chemists not only in those Greeks and Ethnics, but also in that same Paracelsus. . . .
>
> "Paracelsus was obscure." I confess this and for the sake of it rejoice. But Hippocrates was also most obscure, nor was there ever understanding from Galen unless it was only partly from the words and the rest from feeling.
>
> "He did not know the method." But Hippocrates also did not know it, or at least spurned it. . . .
>
> "Paracelsus often placed contraries as principles and Proteus himself did not differ from himself as much as Paracelsus does from Paracelsus." Actually, unless indulgence be given to this mistaken recollection we shall be forced to admit that Hippocrates differed from himself an infinite number of times. I call to account Cardanus and Rorarius, and even Erastus, who have noticed various contradictions of his.
>
> "But Paracelsus was also a magician and an impostor who had dealings with demons. He so indulged in drunkenness that he drank for whole days and nights with farmers, porters and the lowest type of hangmen." Which things I might concede to be all true: however, the

defenders of Galenic medicine have similar faults and even worse ones by far . . . (at this point he goes into the details of an abortion Hippocrates performed on a dancing girl and the impiety of Galen). . . . Now I come to the ignorance of Paracelsus in learned and humane letters: and although I might stain him somewhat, still I cannot concede as much as this man wishes. For he knew the Galenic doctrine, he has commented on Hippocrates: he examined the Arabs, he delivered a book on tartar with a surgery to some schools in Latin letters, and he lectured publicly in the Academy at Basel. It is true that "Paracelsus spoke a great deal in German", but in the same manner Hippocrates spoke Greek as naturally both of them spoke their native tongues. Is this worthy of reprehension in Paracelsus and to be passed over in Hippocrates, Aetius, Actuarius, Galen and Moschion? . . .

"Paracelsus was ignorant of Logic, Physics, Astrology, and Geometry." And what might I say of those Galenic sectarians of whom no one could define their art so that either it might satisfy others or themselves? For this one contends it to be an art, that one a science: a third, both of these and neither: the fourth defines it from its end: the fifth from the work: the sixth from the occurrences: the seventh says that "Medicine is an art of curing and bringing health": but he adds to it "in the human body", as if truly the nature and name of medicine was more fitting to this end than to the curing of plants, or even cattle . . . (he concludes by ridiculing the predictions of the astrologers and the) . . . ignorance of the Geometers is so marked that they assert their defence of the revolution of the earth and seas with preciseness, however, as to how much distance separates London from the little town of Iselinus, they know equally as little. But although that Galenist was not ashamed to call Paracelsus the object of hatred of heaven and earth, it would now seem that the shame has lept across from one party to the other[80].

[80] *Ibid.*, 89–93. . . . Chemistas a patrum auctoritatibus omnino recedere: id quod in aliquibus si faciant, probum honestum judico: si vero in omnibus (ut is malitiose fingit) censeo periniquum. . . . Dicit chemistas omnis politioris doctrinae ignaros esse: graecos non legisse auctores, Arabes vix a limine salutasse, a solo Paracelso, ebrio, mago, impostore, agyrta, circumforaneo, obscuritatum, artifice, coeli, terraeque odio edoctos. . . . in sua ipsius arena provoco, & secum in Graeca Arabicave planitie confligere, neutiquam timesco solus. . . . Ad Paracelsi vitia. . . . Cabala naturalis, Pyrotechnia, Medicamentorum exaltatio, Physices contemplatio, festivitas, mirabilis inventio, ingenium singulare Paracelsi; Haec Chemicos delectant, capiunt, alliciunt, attrahunt; Magia non naturalis, ebrietas, maledicentia, methodi contemtus, ea quidem omnia a Chemicis non solum in Graecis illis & Ethnicis, sed etiam in ipso Paracelso reprehenduntur. . . . "Fuit obscurus Paracelsus": fateor & causa jubet. Sed quoque obscurissimus Hippocrates, neque a Galeno qua verba, qua sententias, intellectus. "Methodum ignoravit." Eandem quoque nescivit, vel saltem sprevit Hippocrates . . . "Paracelsum contraria quandoque ponere principia: tam Proteum a seipso, quain Paracelsum a Paracelso differe." Verum nisi huic μνημονικῶ errato venia detur, educemus denuo Hippocratem infinities a seipso dissentientem. Testor Cardanum, Rorarium, ipsumque adeo Eraſtũ, qui varias ipsius contradictiones

continued on opposite page

There can be little doubt from the known intentions of the College in 1585 and 1589 in regard to the Pharmacopoeia, that the members were a forward looking group of men. Like the surgeons they were ready and willing to accept any new remedies which might prove fruitful, and it is unfortunate that this proposed Pharmacopoeia was never completed. However, the first London Pharmacopoeia that was issued by the College (1618) did contain sections on chemical remedies. This can be seen to be hardly a revolutionary advance at that time, since the members were on record as having approved of these remedies over thirty years earlier.

The Paracelsian influence may also be seen in the extension of chemical methods to urinalysis and the analysis of mineral waters. In both these fields Leonard Thurneisser had written authoritative works in the 1570's[81], and their influence seems to have been felt in England. Paracelsus, also, had ridiculed the traditional uroscopy, and he had emphasized that urine samples should be distilled for an analysis. Following these men R. Bostocke echoed that

> The folowers of ye Ethnikes in judgement of Urin (most of them) take upon them to pronounce of al diseases in any part of mans body,

[81] On Paracelsian urinalysis see Pagel, *Paracelsus*, 189–200. Thurneisser's mineral water analyses are discussed by Gernot Rath in his article "Die Anfänge der Mineralquellenanalyse", *Medizinischen Monatsschrift*, **7**, 1949, 539–41.

---

[80] *continued*

animadverterunt. "Sed fuit Paracelsus quoq' magus, impostor, habuitq' cum daemonibue commercium. Ebriatati ita indulsit, ut integros dies noctesq' cum rusticis, bajulis & faece carnificum compotaret." Quae si vera esse omnia concederem: habent tament Galenicas medicinae patroni similes naevos, vel multo turpiores quidem. . . . Nunc venio ad ignorantiam Paracelsi in literis scientiisque humanioribus: quam uti non inficior fuisse aliquam, ita nec concedo tantam, quantam is esse vult. Nam Galenicam novit doctrinam: in Hippocratem commentatus est: Arabes examinavit: librum de tartaro una cum Chirurgicis aliquot scholiis latinis mandavit literis, & publice in Academia Basiliensi dictavit. Verum esto, "Paracelsum germanice tantum locutum esse", quin & tantum graece Hippocrates; uterque scilicet patriam tantum linguam Hoccine in Paracelso reprehensione dignum, & praetereundum in Hippocrate, Aetio, Actuario, Galeno, Moschione? . . . "Paracelsus Logices, Physices, Astrologiae, Geometriae fuit ignarus." Et quales illius Galenici consectatores dicam, quorum nemo ita suam artem definivit, ut vel aliis vel sibi satisfaciat. Hic enim artem esse contendit: ille scientiam: tertius utramque & neutram, sed quodam modo: quartus a fine: quintus ab opere: sextus ab eventu definit: septimus "Medicinam artem esse dicit curandae sanitatis": sed illud etiam adjungit, "in corpore humano". Quasi vero natura nomenque medicinae plus huic, quam plantarum curationi, vel etiam κτηνιατρικὴ conveniat. . . . Geometrarum quoque tanta deprehenditur inscitia, ut terrae marisque ambitum se exacte tenere autumant, quantum tamen Londinum ab Iselini distat oppidulo, juxta cum ingnarissimis sciunt. Quod vero Galenicus ille Paracelsum coeli terraeque odium vocare non erubescit, pudoris cancellos data opera transiliisse videatur.

> by looking on the water, . . . The Chymicall Phisition affirmeth that such judgement of urine is monstrous. . . .[82]

He too suggested that true results might be obtained if the distillation procedure was applied[83]. Unfortunately he ignored the description of specific gravity tests in Paracelsus, which was the only significant advance made by him in this field. Bostocke's treatise was ignored by his contemporaries and only forty years later, in James Hart's rejection of the chemical analysis of urine, was there any later indication of interest in this odd extension of chemistry[84].

Far more significant is the growth of analytical knowledge seen in the works on spa waters. William Turner, through whom Paracelsus was first mentioned in an English book, told of his own examination of the waters at Bath (1557). In essence, he merely scooped up some of the slime from the bottom of the spring—noted its odour and then concluded that the chief mineral present was brimstone[85]. This is such a primitive procedure that it certainly does not deserve to be considered an analysis, but there were striking changes in method toward the end of the century. In 1572, Thurneisser had published his *Pison*, which described chemical analyses of all the more important German baths. Here he stressed that all samples analysed should be of a standard weight. In the actual analysis the sample was to be filtered, reweighed, and then distilled to dryness. The resulting precipitate was then weighed, dissolved in clear water and crystallized. The purified crystals were then subjected to a series of tests for their identification[86]. In the late 16th century little was known of colour indicators, although the juice of Gall was used for the determination of vitriol. The *Pison* was followed up with many other similar treatises on the continent, and, although this was not a very popular topic in England, its influence was soon felt there as well.

In 1587, Walter Bailey, a physician to the Queen, published an account of the medicinal waters at Newnam Regis in the county of Warwick[87]. Bailey

[82] R.B., Esq., *op. cit.*, Chap. 8, section 17.

[83] *Ibid.*

[84] For a lucid analysis of Hart's work in this field see Pagel, *Paracelsus*, 196–8. Hart's work on urinalysis is best set forth in his *The Anatomie of Urine*, London, 1625, where he discussed the Paracelsian approach to this problem on pages 119–21. However, he had in 1623 translated a similar work by Peter Forrest entitled *The Arraignment of Urines*. In his preface to this latter work he also attacked the chemical analysis of urine (see folio A2).

[85] William Turner, *op. cit.* (1568 ed.), f. 1.

[86] Rath, *op. cit.*, 540. Leonhart Thuneisser zum Thurn, *Pison* (Frankfurt an der Oder), 30–8.

[87] Walter Bailey, *A Briefe Discours of certain bathes or Medicinall Waters in the Countie of Warwick neere unto a village called Newnam Regis*, London, 1587, 10–13.

felt there was a need to identify the minerals in the spring, and he proceeded to distill and evaporate his sample. When a sufficient amount of salts had precipitated, he then filtered them and analysed them by their taste, colour, and their reaction when added to fire. He concluded that the mineral matter present consisted of limestone, nitre, alum and iron.

Another work published in 1600 suggested that the trade in mineral waters be stopped, and that the minerals themselves should be isolated and shipped to cut down the transporation costs[88]. Then in 1626 and 1631, descriptions of the baths in Yorkshire and Bath, for the first time in England, describe colour indicators for vitriol determinations and for acid-alkali determinations, as well as giving detailed directions for the identification of salts by their crystal form[89].

There was, then, no sincere attempt among English medical men to prevent the application of chemistry to medicine. Few if any of them would have approved of Bostocke's assertion that true medicine is nothing but chemistry, but most of them were willing to accept anything valuable which might come from the use of this art. Nothing shows this intensified interest better than the increased knowledge displayed in the works on mineral water analysis. As far as the chemical medicines were concerned, they were accepted by surgeons and physicians alike with no significant Galenist opposition.

A definite compromise had been reached in England in regard to this new medicine. The occult aspects of Paracelsian theory were rejected, while the new remedies were eagerly accepted provided that they proved their worth. This was the compromise position set forth by William Clowes and most other surgeons. It is seen also in the London physician Stephen Bredwell who fought the "pernicious impostures and sophistications" of the Paracelsians, but who at the same time wanted to establish a chemical lectureship at the Royal College of Physicians[90]. Another member of the College, Francis Herring, was willing to commend Paracelsus as "a skilfull Chymicall writer and worker", but, he continued,

[88] Anon., *A Briefe Discourse of the Hypostasis, or substance of the water of Spaw* (tr. from the French by G.T., London, *c.* 1600), 3.

[89] On the analyses to the Yorkshire spa at Knaresborough (Harrogate), see Michael Stanhope, *Newes out of York-Shire: Or, An Account of a Journey in the True Discovery of a Souveraigne Minerall, Medicinall Water*, London, 1626, 6; Michael Stanhope, *Cures Without Care, or a Summons to all Such Who Find Little or no helpe by the use of ordinary physick to repaire to the Northerne Spaw*, London, 1632, "To the Reader". For the tests at Bath see Edward Jorden, *A Discourse of Naturall Bathes, and Minerall Waters*, London, 1631, 73–6.

[90] John Gerarde, *The Herball or Generall Historie of Plantes*, London, 1597, introductory non-paginated leaf entitled "To the well affected Reader and peruser of this booke" by Stephen Bredwell.

> I have often marvelled how any man of wisdome and modestie, seeing the incredible insolencie and impudencie, the intolerable vanitie and follie, the ridiculous and childish crakings and vantings of Paracelsus should once commend him without noting his contrary vices, and giving him a dash with a blacke coale[91].

The role played by Paracelsus in this Renaissance transformation of pharmacy was ignored by most Elizabethans. Although the works of Paracelsus and his followers had been primarily responsible for this new interest in chemical medicines, Paracelsus was at best listed as one of many who approved of these remedies, and most of the credit went to Conrad Gesner and those of the ancients who had been in favour of these cures.

Therefore, in England, chemical therapy had won acceptance not by overturning the Galenic system, but by allying itself to it. On the continent the conservatives, who had been shocked at the desire of Paracelsus to discard the whole ancient medical corpus, began to band together as a faction shortly after the middle of the century. There were two clearly defined groups, the one wishing to discard much of the old medicine, while the other, in defence, clearly being forced to adhere to its authorities rigidly. When Conrad Gesner came along at a later date—he was only eleven when Paracelsus had burned the Canon of Avicenna—and as a compiler put together a group of chemical remedies from various authors, his production was not to cause any widespread controversy.

But in England the situation was reversed. Outside of the translation of Brunschwig's work on distillation which had appeared in 1527, and the translation of one of Arnold of Villanova's works (1540), the first work of chemical remedies, both organic and inorganic, was the *Treasure of Euonymus* of Gesner. This was not a theoretical volume, but it did make available a great number of useful remedies. Most important, was the fact that although the author had no recourse to Galen or Hippocrates in its compilation, he sought no quarrel with them. In the 1560's and 1570's the English physicians had no cause to believe that these remedies implied any conflict with the existing system. When the first comments on Paracelsus and the Paracelsian theories were printed in England in the monographs of John Jones and George Baker in the seventies, they were based not on the works of Paracelsus himself, but rather based on the refutation of his theories by Thomas Erastus. When R. Bostocke tried to present a more accurate summary of the Paracelsian system, his work attracted very little interest. The other outstanding Paracelsian treatise of this period by an Englishman was the tract by Thomas Moffett, but although

[91] Francis Herring, *A Modest Defence of the Caveat given to the Wearers of impoisoned Amulets as Preservatives from the Plague*, London, 1604, 32 f.

he appears to have read widely in the Paracelsian corpus, his problem was primarily to aid in the acceptance of the new medicines, and, in any case, his work was never printed in England and it seems to have attracted little attention there. It is safe to assume, however, that his views were known to his colleagues in the Royal College of Physicians.

The rest of the chief supporters of the new medicine in England were interested less in theory than in practice, and thus John Hester and the members of the College of Surgeons can be placed in the Gesnerian rather than the Paracelsian tradition. While on the continent a physician often was in a position where he could only choose between an almost complete overthrow, or an equally complete dominance of the Galenic medicine, in England the physician had not only these choices, but also a third, the acceptance of the Galenic system with the addition of whatever was found valuable in chemical therapy. Logically enough it was this third solution which found almost immediate acceptance, even in the supposedly conservative Royal College of Physicians. The more complete exposition of Paracelsian thought which appeared with the Duchesne translation of Thomas Tymme in 1605, and Tymme's own defence of it in 1612, as well as the Fluddean system of the world which began to be published in 1617, did nothing to reverse this trend.

Paracelsus and his theoretical reforms were very unpopular even before they were really explained, and the view toward them which was taken in the first ten years after their introduction, was basically the same as that expressed in the *Pharmacopoeia* of 1618. The chief translator of works on spagyrical medicine had been John Hester, and it is significant that he was far more interested in the recipe books of Duchesne and Fioravanti than in Paracelsus. His two short translations from works falsely attributed to Paracelsus were composed of chemical recipes, not of iatrochemical theory, and that which is even more important is the fact that they were the only translations attributed to Paracelsus until the 1650's, when the work of van Helmont and others brought renewed interest in the Paracelsian corpus. The conflict which developed at that time was far more violent than that which led to the Elizabethan compromise in medicine, and it resulted in the translation of many more works of Paracelsus in the decade of the 1650's plus a reprint of the Hester translations, but its final result was to confirm the stand first taken by the Elizabethans.

ATOMISM IN ANCIENT GREECE AND INDIA

By R. A. Horne*

I

Introduction

For many Eastern minds the destruction of Hiroshima by a nuclear weapon has come to assume the proportions of the ultimate racist gesture. Yet the atomic bomb is not entirely the diabolical invention of the West. Atomism is as much a part of the tradition of the East as of the West. The West was more persistent in the development of the idea and thus, quite naturally, was the more successful in providing the occasion for abuse.

The history of the development of atomism in the West is familiar to many; the names of Democritus, Epicurus, Lucretius, Gassendi, Dalton, Rutherford, Thomson, and Bohr are well known. The same cannot be said of the origins of atomism in ancient India and of its elaborate development there. The comparisons and relations, if any, between ancient atomism in India and in Greece have remained relatively obscure. In the present discussion I plan to compare the forces responsible for the formulations of atomistic philosophy in Greece and India;[1] the principal tenets of these theories; the course of their subsequent elaboration; and their dissemination, the former to Rome, the latter to Cathay; the forces responsible for the decline of these philosophies; and, finally, I wish to mention the perennial suggestion that the one might have influenced the other.

* Present address: 406 Marlborough Street, Boston, Mass.

[1] For Greek atomism see C. Bailey, *The Greek Atomists and Epicurus*, Clarendon Press, Oxford, 1928, and, more recent, Chapter V in S. Sambursky, *The Physical World of the Greeks*, Macmillan Co., New York, N.Y., 1956. For Indian atomism see J. C. Chatterji, *Hindu Realism*, Indian Press, Allahabad, 1912; S. Dasgupta, *A History of Indian Philosophy*, Cambridge University Press, Cambridge (England), 1922–55, Vol. I, Ch. VIII, pp. 286ff., 326ff.; B. Faddegon, *The Vaisesika-System*, J. Müller, Amsterdam, 1918; A. E. Gough (Ed.), *The Vaisesika Aphorisms of Kanada*, Lazarus & Co., Benares, 1873; A. B. Keith, *Indian Logic and Atomism and Exposition of the Nyaya and Vaisesika Systems*, Clarendon Press, Oxford, 1921; S. Radhakrishnan, *Indian Philosophy*, Allen & Unwin, London, 1927, Vol. II, Ch. III; S. Radhakrishnan and C. A. Moore (Eds.), *A Source Book of Indian Philosophy*, Princeton University Press, Princeton, N.J., 1957; B. N. Seal, *Positive Sciences of the Ancient Hindus*, Longmans, Green & Co., London, 1915; U. Mishra, *Conceptions of Matter According to Nyaya-Vaisesika*, Pub. author, Allahabad, 1936.

II

The Origins of Indian and Greek Atomism

In terms of the dialectic of history little ambiguity surrounds the origins of atomism in Greece. Heidel[2], assuming a continuity of the traditions of Ionian physics, would trace the origins of Greek atomism to the effort to devise naturalistic explanations for a variety of phenomena—for evaporation and condensation, for nutriment and respiration. Now, while the Greek Atomists were highly pleased to discover that their theories did provide rational and coherent explanations for a wide range of empirical observations, this happy result was a dividend rather than the purpose of their endeavour. Greek Atomism represented the response to metaphysical more than to physical problems and, when viewed in this light, takes its place neatly in the development of pre-Socratic philosophy generally. Pre-Socratic speculation concerned itself with three major questions: the One and the Many, Being and Becoming, and the Way of Truth and the Way of Opinion. The last was primarily an epistemological problem and will not concern us further.

The monism of Thales and his successors appeared to be inadequate for accounting for the obvious richness of Nature. The response to Ionian monism was twofold . . . Empedocles found room for the primal elements of all of the Ionians in his pluralistic theory of the four elements, while Anaxagoras suggested a novel approach in his protoatomistic seed hypothesis. However, neither of these solutions was intrinsically satisfactory. The inclination for unity and simplicity prevailed, and Parmenides and his Eleatic School insisted on a most intransigent monism. Because of the cogency of the dialectic method which they had developed (The Way of Truth), exemplified by the famous paradoxes of Zeno, this philosophical extremism could not be dismissed. Similarly, the Eleatics precipitated a crisis with respect to the problem of change. Heracleitus had concluded that all was in a state of flux; the Eleatics insisted that change was illusory. The Eleatic position was manifestly in disagreement with human experience. Either philosophy or the evidence of the senses had to be jettisoned.

Leucippus and Democritus were able to come to the rescue and salvage both phenomena and metaphysics. The senses' world of ceaseless change was a consequence of the concourse of changeless atoms through the void. The endless multiplicity of Nature arose from the limitless permutations of the simple atoms which combined much as letters of the alphabet can be combined to form words, lines, even the *Iliad*. The purpose of Greek atomism, then,

[2] W. A. Heidel, "Antecedents of Greek Corpuscular Theories", *Harvard Studies in Classical Philology*, **22**, 111 (1911).

was to provide solutions to certain metaphysical problems which had arisen. The immediate application of this atomism to specific phenomena was welcome, encouraging, yet secondary. It was, however, to receive increasing attention . . . so at least we gather from the many examples of detailed observation in Lucretius' Latin poem *De rerum natura*.

Despite its metaphysical beginnings the purpose of Greek atomism became ultimately to confront phenomena; that of India, in contrast, to escape from the phenomenological world. According to legend, a group of disciples approached the sage Kanada and asked him how they might find release from mortality and attain self-realization. The answer, curiously enough, was a treatise on atomism . . . the *Vaisesika-Sutra*. Vaisesika is but one of the six orthodox philosophies: Nyaya, Vaisesika, Samkhya, Yoga, Mimasma, and Vedanta[3]. Two of these "insights", Vaisesika and Vedanta, embrace systematic world-views; the former can be said to offer a naturalistic or scientific world-view, the latter, which holds that the evidence of the senses is an illusion, counters with a spiritualistic world-view. Vaisesika philosophy, as we have seen, seeks to escape from the phenomenological world by wrapping the whole realm of external existence up into a neat explanatory parcel, atomism, so that the intellect need no longer trouble itself with such problems and is thus free to continue on to the higher spheres of thought which are its more appropriate concern.

In a sense, Indian and Greek atomism do have one feature in common. They were both preceded by extravagantly unrealistic philosophies . . . the orthodox Hindu doctrine that matter is unreal and the Eleactic dogma that change is illusory. Both, therefore, may be said to have represented attempts to save phenomena in times of philosophical crisis.

Aristotle flourished roughly one hundred years after Leucippus. Had Leucippus been the consolidator rather than the originator of atomistic philosophy in Greece, we would expect Aristotle with his customary thoroughness, and especially in view of the respect in which he held the Atomists and their doctrines[4], to have been aware of and to have made mention of the fact. He does not. Neither did Diogenes Laertius who, although writing centuries later, had a quick ear and should have heard of any atomistic predecessors of Leucippus had any existed. Diogenes mentioned only Zeno, most emphatically not an atomist, as a master of Leucippus[5]. Greek atomism, then, appears to

[3] T. Bernard, *Hindu Philosophy*, Philosophical Lib., New York, N.Y., 1947, pp. 4ff.; H. Zimmer, *Philosophies of India*, Pantheon, New York, N.Y., 1951, p. 605.

[4] Aristotle, *De Generatione et Corruptione*, 315*a*35; *cf.* A. Dyroff, "Ueber die Abhangigkeit des Aristoteles von Demokritos", *Philologus*, **63**, 41 (1904).

[5] Diogenes Laertius, *Lives and Opinions of Eminent Philosophers*, ix, 30.

have been the invention of Leucippus. But Greek atomism, as we have seen, did have its context. There were the provocative problems posed by the Heracleitean-Parmenidean antinomy, there was the Empedoclean theory of the four elements, more immediately there was the "seed" hypothesis of Anaxagoras—an unmistakable proto-atomism, and finally there was the geometrical monadology of the Pythagoreans[6].

We know little about Leucippus; we know still less about Kanada. Consequently the origins of Indian atomism are even more obscure than those of its Greek counterpart. Vague atomistic notions possibly may have enjoyed a limited circulation in pre-Kanadian speculation, but these ideas, if they did exist, did not find their way into permanent record until Kanada. Because of the obscurity of its antecedents Kanada's philosophy appears to be of a more *ex nihilo* nature than that of Leucippus. Nevertheless the suspicion has remained that he was the compiler and systemizer rather than the originator of Indian atomism.

The Samkhya-system, believed to be the oldest of the six fundamental interpretations of Ultimate Reality, was elucidated by Kapila, the "Father of Hindu Philosophy", in the sixth century B.C. This philosophical system views the world in terms of manifestations of Spirit and Matter. It holds that there are five subtle particles corresponding to the five elements and derived by processes of differentiation and unequal aggregation from a super-subtile, homogeneous rudimentary matter. In a crude way this Samkhya "Atomism" may be taken to be analagous to the hypotheses of Anaxagoras or Empedocles, adumbrating but never explicicating the corpuscular physics of the Vaisesika[7].

III

A Comparison of the Principal Doctrines of Indian and Greek Atomism

Tyndall's summary of the principal tenets of the Greek atomists is particularly terse; it has been cited by Millikan, requoted by Loring[8], and I should

[6] See F. M. Cornford, *Plato and Parmenides*, Routledge & Kegan Paul, Ltd., London, 1939, Ch. III.

[7] A. P. C. Ray, *History of Chemistry in Ancient and Medieval India*, Indian Chem. Soc., Calcutta, 1956, pp. 43ff.

[8] F. H. Loring, *Atomic Theories*, Methuen & Co., Ltd., London, 1921, p. 1.

like to repeat it here third-hand[9]:

(1) From nothing comes nothing. Nothing that exists can be destroyed. All changes are due to the combination and separation of molecules.

(2) Nothing happens by chance. Every occurrence has its cause from which it follows by necessity[10].

(3) The only existing things are the atoms and empty space; all else is mere opinion.

(4) The atoms are infinite in number and infinitely various in form; they strike together and the lateral motions and whirlings; which thus arise, are the beginnings of worlds.

(5) The varieties of all things depend upon the varieties of their atoms, in number, size and aggregation.

(6) The soul consists of fine, smooth, round atoms like those of fire. These are the most mobile of all. They interpenetrate the whole body and in their motions the phenomena of life arise.

The principal tenets of Vaisesika atomism are:

(1) Matter is not infinitely divisible.

(2) The paramanus (atoms) are without parts; they cannot be produced or destroyed; they are thus eternal. But their aggregates are not, and the formation and separation of these aggregates constitute creation and dissolution.

(3) The paramanus are in motion.

(4) Two points (anus) describe a line or one-dimensional binary form (Dvyanuka); three lines describe a ternary form (Tryanuka), hence arises the three-dimensional phenomenological world.

[9] Details may be found in C. Bailey, *op. cit.*, pp. 117ff. Major extant primary sources of classical atomism are the Leucippean and Democritean fragments (see K. Freeman, *Ancilla to the Pre-Socratic Philosophers* (trans. of Diels' *Fragmente der Vorsokratiker*), Oxford, 1948), the discussions and refutations of Aristotle (see T. W. Organ, *An Index to Aristotle*, Princeton, 1949), the works of Diogenes Laertius and Sextus Empiricus (both available in bilingual Loeb Classical Lib. Ed.), the letters of Epicurus and *De Rerum Natura* of Lucretius (available in one volume, W. J. Oates, Ed.), *The Stoic and Epicurean Philosophers*, Random House, Inc., New York, N.Y., 1940), and the preface of the *Pneumatica* of Hero of Alexandria (Edition of Woodcroft, London, 1851).

[10] A tradition of error, common in antiquity and still persisting (see J. Maritain, *An Introduction to Philosophy*, Sheed & Ward, Inc., New York, N.Y., 1937, p. 53), criticizes the Greek Atomists for attributing everything to chance. "They [excluding the Epicureans] were, on the contrary, strict determinists" (B. Russell, *A History of Western Philosophy*, Simon & Schuster, New York, N.Y., 1945, p. 66).

(5) The kinds of paramanus depend on their distinguishing characteristics. The four special qualities (Visesas) which permit discrimination and classification of the paramanus are odour, flavour, form, and touch.

Atomism is, in principle, a very simple hypothesis, and herein lies its attractiveness. For this reason Greek and Indian atomism display more similarities than differences. With respect to the fundamentals . . . the indivisibility of the atoms and the mutability of Nature through the mechanism of the formation and dissolution of aggregates of atoms . . . they are in agreement, but in matters of more particular consideration certain differences appear. Most important of these concerns what came to be called the problem of secondary qualities. The Indians assigned qualities such as odour, flavour, and touch to their atoms which Leucippus and Democritus denied. We need not seek far for the reason behind this difference. The roots of Indian atomism were epistemological, those of Greek atomism ontological. The Indian corpuscles are differentiated on the basis of sense impressions, of discrimination, of the sensual discernment of their distinguishing characteristics; whereas Greek Atomism, by way of contrast and with typical pre-Socratic emphasis on physics rather than psychology, accepts the atoms and the void as the given facts of Nature and proceeds to derive the sense-impressions therefrom in terms of the interaction of the atoms with the organs of sense. The Greek atoms possess only the most minimal properties: size, shape (and smoothness), arrangement, and possibly weight.

Perhaps a more fundamental difference between Indian and Greek atomism from a purely physical point of view is that the atoms of Kanada, unlike those of Democritus, are dimensionless. This, as we shall see, formed the basis of the attacks on Kanada's atomic system.

IV

The Development of Greek and Indian Atomism

The development of Indian atomism is a feeble, devious and turgid stream, while that of Greek atomism is strong, straight, and limpid. The latter observation is convincing testimony of the consistency and cogency of the Democritean system. There were, of course, certain streams of thought which flowed concurrently with Democritean atomism. There was, for example, the Pythagorean monadology which appeared from time to time and in such unlikely places as in those well-known passages in the *Timaeus*[11] and whose exact relation with true atomism the historical record has left unclear; there

[11] Plato, *Timaeus*, 54D *et seq.*

were springs of thought such as Aristotle's theory of natural nimima[12] which, while not derived from atomism, were cognisant of it; and there was finally the most curious fate of the School of Democritus proper when determinism was transformed into scepticism, when via Nessas of Chios, Metrodorus of Chios, and Anaxarchus of Abdera, the atomistic stream was almost swallowed up by the desert of Pyrrhonism. The inherent strength of Democritean atomism, however, enabled it to endure even this catastrophe. Nausiphanes was a follower of Pyrrho, and Epicurus was a pupil of Nausiphanes. With the exception of the infamous "swerve hypothesis"—a most important exception—which Epicurus may have introduced in order to avoid a strict determinism which would vitiate his, or any, ethical system, Epicurean atomism is in essence the same as that of Leucippus and Democritus. And so it remained, even in dormancy, until the seventeenth century when it was revived by Gassendi and others. With the exception, I repeat, of Epicurus, Descartes was the first to make a serious attempt at altering atomistic philosophy[13]. The system of Democritus was so highly developed and perfected in itself, that the best certain minor atomists such as Heraclides of Pontus and Ecphantus of Syracuse could do in the way of "improvement", was to attempt to graft upon it certain Empedoclean and Pythagorean notions. Democritean atomism found its way without serious alteration *via* Strato and Hero into the sciences of pneumatics and hydraulics and even, through the mediacy of Aegimus of Elis, Erasistratus of Chios, and Asclepiades of Bithynia, into medical theory.

The fortunes of Indian atomism form a picture of far greater complexity. Once established as one of the six official world-views Vaisesika itself underwent relatively little change. But in this instance the want of change seems to be attributable more to neglect than to any cogency of the philosophical system. Epicureanism, we must remember, was one of the dominant philosophies of the Hellenic world, finding a rival only in Stoicism[14]; Vaisesika-philosophy never attained comparable eminence and was overshadowed by its sister philosophies. In those marginal areas where Indian interest in atomism did persist, however, the idea was transformed in many and strange ways.

These developments are too numerous to follow them all in detail. Rather, and by way of example, I wish to mention briefly only a few of these derivative

[12] For further discussion of the Aristotelian minima see A. G. van Melsen, *From Atomos to Atom*, Duquesne University Press, Pittsburgh, Pa., 1952.

[13] The atomism of Giordano Bruno (1548–1600), while influenced to some extent by the great poem of Lucretius, was more in the tradition of the Pythagorean-Platonic monadology than in that of Leucippus, Democritus, and Epicurus.

[14] For an extended discussion of the conflict between Epicureanism and Stoicism see S. Sambursky in the reference cited above.

systems. Perhaps the most interesting extension of atomism is the concept of atomized time. A temporal atom is the moment required for the sun to pass over an object of atomic dimensions and is equal to 1/202,500th of a second. According to this doctrine of momentariness even the mind-substance is of an atomic nature. States of consciousness only *appear* to be a continuous succession. For Ajivika-philosophy the atom is the most primitive organism. The life monad must undergo a series of 84,000 births, starting with the elemental atoms of ether, fire, earth, and water.

Traces of atomism are detectable in Samkhya and Yoga philosophies. Atomism also managed to insinuate its way into the two great heterodox systems of Indian theosophy—Jainism and Buddhism. According to Jain physics matter exists in six degrees of density, the most "subtle-subtle" being the invisible substance of the atoms[15]. Jain atomism exhibits some novel features. The Jain atoms, for example, can alter their qualities. Yet the Jain School develops the atomic theory even to a less degree than Vaisesika-philosophy, "one of the many proofs", writes Keith[16], "Of the metaphysical barrenness of the school"[17].

As for atomism's influence on Buddhist speculation, The Blessed One incorporated notions of atomicity into his poetic vocabulary[18], and atomism became a part of the metaphysics of certain Buddhist sects such as the Sautrantikas. This group formulated a temporal atomism, a momentariness of all things, a sort of cinematographic world-view, that has been compared with the idea of continuous creation as elaborated by the Muslim Mutakallimun[19,20].

In summary we may say that Greek atomism was so perfected in the hands of Leucippus and Democritus that it was able to preserve its identity, while the atomism of Kanada, far less perfect in the systematics of its structure, altered in many and sometimes peculiar ways as it encountered and was gradually swallowed up by India's countless metaphysical persuasions.

[15] H. Zimmer, *op. cit.*, p. 271.

[16] A. B. Keith, *op. cit.*, p. 16.

[17] For further reading concerning Jain atomism see H. T. Colebrooke, *Essays on the Religion and Philosophy of the Hindus*, Williams & Norgate, London, 1858, pp. 249–51; and C. Eliot, *Hinduism and Buddhism*, E. Arnold & Co., London, 1921.

[18] See E. A. Burtt, *The Teachings of the Compassionate Buddha*, Mentor Books, New York, N.Y., 1955, pp. 157f.

[19] D. B. Macdonald, "Continuous Creation and Atomic Time in Muslim Scholastic Philosophy", *Isis*, **9**, 326 (1927).

[20] The doctrine of continuous creation has been reintroduced into modern cosmology. The idea was dismissed by some as a scandalous novelty . . . not very complimentary testimony to their knowledge of the history of science.

V

The Decline of Greek and Indian Atomism

Greek atomism was abandoned; Indian atomism was diluted and declined. The causes of this decline were numerous. Two, however, deserve mention. Historically there was the matter of attenuation and absorption by other speculative systems. But Indian atomism was also cursed by certain inherent faults which doomed its chances of success. Kanada's atoms lacked extension[21], and criticism was not slow to focus on this vulnerable point. Indeed the principal arguments advanced against Kanada'a system all appear to have had their foundation in this issue. In order to remedy this difficulty one of the Theravada Schools, the Vaibhasikas of Kasmir, proposed a six-sided atomic model[22]. But the Mahayana Buddhists[23] continued to concentrate their critical assaults on the atom's want of extension. One of their number, Vasubandhu, attempted to discredit physical reality on the basis of a critique of atomism[24], in particular, their lack of extension, and this tendency of thought was taken up and pushed to its illogical extreme by the brilliant dialectician Nagarjuna. The result was a nihilistic philosophy which maintained that only the void is real. This doctrine of vacuity (cunya-vada) found a responsive chord in Buddhism and won many adherents. Here again we have an interesting comparison: the epigoni of Democritus pursued the road to Pyrrhonism while the critics of Kanada chose that which lead to nihilism. Greek atomism, nevertheless, was strong enough to recover from this setback and, in its Epicurean form, to become one of the two principal philosophies of the Roman world; Indian atomism was not, and so wasted away.

Greek atomism was exposed to four severe trials: the criticism of the Sophists (including Socrates), the condemnation of Plato, the criticism of Aristotle, and the competition of Stoic physics.

Sophism was symptomatic of a profound revolution in Greek society and philosophy, of a fundamental change of outlook precipitated by the adversities of the Peloponnesian War. "Of all things", said Protagoras, "the measure is

[21] For this reason L. Mabilleau, *Histoire de la Philosophie atomistique*, F. Alcan, Paris, 1895, has compared them with the point-centre-of-force atoms of Boscowich.

[22] S. Radhakrishnan, *op. cit.*, Vol. I, pp. 616–22.

[23] For further reading concerning Mahayana Buddhism see D. T. Suzuki, *Outlines of Mahayana Buddhism*, Luzac & Co., London, 1907; and C. H. S. Ward, *Buddhism*, Epworth Press, London, 1952, Vol. II.

[24] Some relevant quotations of Vasubandhu are contained in E. A. Burtt, *op. cit.*, pp. 167–78.

man". According to this new humanistic attitude the proper study for man is not the heavens or the elements but rather man himself. For the Sophists, and for Socrates, the science of their predecessors had little attractiveness because the investigation of the things which *really* matter in life—virtue, truth, and beauty—appeared to be outside of the province of the disciplines that they had founded. This criticism of the natural sciences was and remains one of some validity. Socrates felt that Anaxagoras (and by implication, the Atomists) had spent his considerable talents unwisely by devoting them to the study of the cosmos rather than to the study of the psyche.

Plato, reacting like a hysterical schoolgirl, thought that the Atomists were, not merely distracted, but downright wicked. Sulkily, he does not mention either Leucippus or Democritus anywhere in his voluminous works. According to Aristoxenus, Plato even tried to burn all the writings of Democritus[25]. Plato's own idea of science was peculiar in the extreme. His programme involved reinstating a fabric of mythological lies which, unlike true science, could be twisted at will to serve the needs of the State. Curiously enough, however, when pressed to produce a cosmological text Plato adopted atomism[26], but the atomism of the Pythagoreans rather than that of Leucippus and Democritus. Although Plato's "scientific" ruminations are, in the accurate estimation of Bertrand Russell, "simply silly"[27], they must be duly mentioned, for the *Timaeus* of Plato became the work of ancient science most extensively studied by the epigoni and thus exerted an influence in the Dark Ages and the Renaissance enormously in excess of its merits[28].

Aristotle's criticisms of atomism are as sensible as those of Plato are foolish. In the first place Aristotle was unhappy in a general way with the strict determinism of the Atomists. Their system left no room for the causes and purposes so dear to The Philosopher's heart[29].

This criticism has little more than emotional grounds, yet it remained the argument most commonly directed at the Atomists. Aristotle's second criticism of atomism was in every sense of the term "scientific", and it centred around certain phenomena, such as the experimental evidence for the non-existence of

[25] Diogenes Laertius, *Lives of Eminent Philosophers*, ix, 40.

[26] Plato, *Timaeus*, 53C *et seq.*

[27] B. Russell, *A History of Western Philosophy*, Simon & Schuster, New York, N.Y., 1945, p. 143.

[28] R. Klibansky, *The Continuity of the Platonic Tradition During the Middle Ages*, Warburg Inst., London, 1950; P. Shorey, *Platonism, Ancient and Modern*, University of Calif. Press, Berkeley, 1938, especially pp. 27, 104–14.

[29] Aristotle, *De Caelo*, 300*a*20ff.; *Metaphysica*, 1071*b*32ff.

the void and the problem of mixing[30], which he felt were not to be best explained atomistically[31]. The spirit of these criticisms is proper; their specific content was in error, yet Atistotle can hardly be blamed. Aristotle, motivated by practicality, preferred a macroscopic rather than a microscopic level of inquiry into the nature of things. Aristotle's criticisms of atomism, like those of Plato, are important, not so much in their immediate effect, as for the influence of Aristotelian philosophy centuries later.

An influence on ancient science, perhaps more immediate than that of Plato, or Aristotle, was that of the Stoics. Indian atomism was carried eastward to Cathay by Buddhism but failed to share Buddhism's triumphs there. Greek atomism, on the other hand, was carried along with the rest of the plunder westward to Rome, and there it enjoyed fresh victories—and finally was discarded. The moralist Epicurus accepted the atomism but not the determinism of Leucippus and Democritus, and Epicureanism became one of the principal, do I dare say popular? philosophies of Rome. Its chief competition was Stoicism. For their cosmology the Stoics adopted a physics of the continuum, and thus brought to fruition certain criticisms of atomism implied by the paradoxes of the Eleatics. The fortunes of western atomism declined as the physics ingredient of Epicureanism was de-emphasized, and the role of the system's moral philosophy enlarged. Eventually the fortunes of Epicureanism, as a whole, set foot on the long downward path of decline. Contrary to what one might expect, Stoicism proved to be more flexible than Epicureanism, and this greater ability to alter with the pressures of the times enabled it to eclipse Epicureanism. Also, due to misinterpretation of their hedonistic ethics, the Epicureans were subjected to much social castigation. It became widely considered to be impious and immoral to subscribe to atomism.

VI

The Absence of Relationship Between Indian and Greek Atomism

A persistent tradition, attributed by Strabo to Posidonis, relates that the atomic theory was invented by Mochus of Sidon. Sanchuniathon of Beirut, another Phoenician who is said to have flourished before the fall of Troy, has also been credited with the origination of atomism. The Phoenicians were enterprising merchants, hardly prone to philosophizing. Even if they did not invent the atomic hypothesis, could they have imported the theory from India

[30] Aristotle, *Physica*, 214*a*28, *a*33, *b*3; *De Caelo*, 305*b*17; *De Generatione et Corruptione*, 327*a*29ff.

[31] Aristotle, *Physica*, 213*a*11ff.

along with their wares? Burnet objects[32] that material goods exchange much more freely among peoples who do not share a common language than do abstract ideas. But Lange, on the other hand, points out[33] that Greek science, including atomism, arose in the easternmost part of the Greek world, in the very area where contact with the East, with Egypt, Phoenicia, Persia, and perhaps even India, was most likely. Heracleitus, possibly the first Greek to mention a corpuscular theory[34], was from Miletus in Ionia, and some say that Leucippus, the father of Greek Atomism, was born in this same city[35]. Abdera, the home of Leucippus and Democritus[36], was founded by refugees from the Ionian capital of Teos. The fact that the teacher of Epicurus, Nausiphanes, came from Teos may be more than a coincidence.

Might not we speculate, then, that Greek atomism was of eastern, or even of Indian, origin? Unfortunately, before we can seriously advance such a suggestion, clearly we must establish that the latter was chronologically prior to the former, and on this crucial point the historical record is in a state of utter chaos. We do not know if Kanada invented atomism or merely systematized and recorded already existing atomic philosophy; in the final analysis we may say the same of Leucippus although, I repeat, it is strange that if he should have had any atomistic predecessors Aristotle fails to mention them. Worst yet, we have no idea when Kanada lived! The fluorits of Leucippus and Democritus, we may be reasonably sure, were about 430–420 B.C., but that of Kanada may be as early as the fifth century B.C.[37], or as late as A.D. 200–400[38]! Samkhya philosophy which, as I have said, may have adumbrated the corpusuclar Vaisesika philosophy, is said to date from the sixth century B.C., but here again the uncertainty is great. So great are the chronological uncertainties that one might argue equally as well that Indian atomism was derived from the Greek. Keith indicates that[39], prior to contact with the Greek kingdom of

[32] J. Burnet, *Early Greek Philosophy*, Adam & Charles Black, London, 1948, p. 17.

[33] F. A. Lange, *The History of Materialism* (3rd ed.), Routledge & Kegan Paul, Ltd., London, 1950, Bk. I, p. 9.

[34] See J. W. Mellor, *A Comprehensive Treatise on Inorganic and Theoretical Chemistry*, Longmans, Green & Co., London, 1922, Vol. I, p. 32. I am indebted to Professor C. T. Kawassiades of the University of Salonica for bringing this reference to my attention.

[35] Diogenes Laertius, *Lives of Eminent Philosophers*, ix, 6.

[36] Democritus himself may have strayed as far as India during his extended wanderjahren.

[37] F. M. Müller, *Indian Philosophy*, Susil Gupta, Ltd., Calcutta, 1952, Vol. IV, p. 2, also Vol. I, pp. 81–2, Vol. IV, pp. 75–7.

[38] H. Zimmer, *op. cit.*, p. 608.

[39] A. B. Keith, *op. cit.*, pp. 17–18.

Bactria, there is not proof of the existence of atomistic philosophy in India. We are thus obliged to conclude that, in the words of Professor Sarton[40], the suggestion of a relation between Indian and Greek atomism is "unproved and gratuitous".

As for the question of the relation, if any, between the atomic ideas of the Indian Sautrantikas and the Muslim Mutakallimun[19], while the chronology is not hopelessly unclear, there is no concrete evidence for assuming any such connexion. But in this instance, which is not so remote in time, the hope that some such shred of evidence might be forthcoming is not entirely vain.

Even if the priority and relations between Eastern and Western atomism could be established, the results, while of course exceedingly interesting in their own right, would actually throw comparatively little light on the greater question of the origins of atomism. They would only defer this problem. A much more fruitful course of inquiry into the origins of atomism appears to be an elaboration and extension of the work of Piaget[41] with children and sociological and psychological investigations of adolescent and adult scientific attitudes. The origins of ideas are vastly more instructive than the details of their transmission. Science conquers by creation, not by adaption.

[40] G. Sarton, *A History of Science*, Harvard University Press, Cambridge, 1952, Vol. I, p. 255.

[41] See R. A. Horne, "Atomistic Notions in Young Children and Young Cultures", *J. Chem. Educ.*, **35**, 560 (1959) and the references cited therein.

ITINERANT LECTURERS IN NATURAL PHILOSOPHY

By F. W. Gibbs*

The emergence of the itinerant lecturers was a peculiarly English phenomenon —the result of conditions in the larger towns where facilities for adult education were lacking. Their most active period corresponds roughly to the time when the Universities of Oxford and Cambridge, as distinct from those of Scotland and Leyden, were all but barred against the Dissenters. In 1790 John Aikin, son of Priestley's former colleague at Warrington, claimed that the Dissenters had been among the principal promoters of all plans for mental improvement, "whether by the lectures of itinerant professors in natural philosophy, or by the establishment of public libraries"[1]. Priestley, for example, had founded the library at Leeds and later helped to develop one at Birmingham, and in his chemical writings introduced three men to whom the title of lecturer in natural philosophy was given—James Arden, Adam Walker and John Warltire. These men, together with the blind lecturer, Dr. Henry Moyes, spent many years in the main commercial and manufacturing centres, showing that experimental science was (in Priestley's words) a rational, useful and honourable pursuit, not merely a particular species of amusement. A correspondent to the *Morning Post* of 12 June, 1782, having just attended one of Walker's lectures at the Lyceum in London, said that such "professors of science seldom advance its limits, or extend its discoveries; but it is an useful thing for mankind that they are the midwives of other people's discoveries". He was surprised to find "a large and genteel company" assembled to hear about the work of Priestley, Kirwan and Volta. Walker had been lecturing on Priestley's "late ingenious discoveries" ever since 1773[2].

Arden, Walker and Warltire gave basic courses that reveal a common plan, together with special lectures and courses on the gases recently discovered by Priestley, on eudiometers and machines for making "artificial" mineral waters, and on metals (as did Warltire in Birmingham). They were not the only men active in this way, but they formed a distinct group of educationists—not merely public entertainers.

* The Royal Institute of Chemistry, London.

[1] *An Address to the Dissidents of England*, 1790, p. 25.

[2] *York Chronicle*, 19 February, 1773.

A somewhat similar basic plan had been adopted by three earlier pioneers in this kind of lecturing—John Horsley, F.R.S. (1685–1732), a Presbyterian minister and schoolmaster at Morpeth, Caleb Rotheram (1694–1752), Master of the Kendal Academy, and Benjamin Martin (1704–82), formerly a schoolmaster at Chichester. Horsley lectured in Newcastle, and his *Short and General Account of . . . fundamental Principles of Natural Philosophy* was revised and "adapted to a Course of Experiments perform'd in Glasgow" by John Booth in 1743. Rotheram acquired Horsley's apparatus for his academy and for his lectures at Manchester; his son Caleb (1738–96) was a friend of Priestley's. Martin supplied the globes Priestley used in his first lectures at Needham Market; in 1743 he published a more ambitious work, *A Course of Lectures in Natural and Experimental Philosophy . . . on the Principles of the Newtonian Philosophy*, at Reading. Aikin[3] said that, as a writer, Martin "possessed a happy method of explaining his subject, and wrote with perspicuity, and even considerable elegance". Though the lectures of such men covered a wide field —applied mathematics, astronomy, physics and geography—it was not until the 1760s that much attention was given to chemistry, and by then Arden, Walker and Warltire were all active. Moyes belonged to a younger generation, together with Walker's sons, and other less prominent men, such as Long, Booth, Burton and Pitt, who lectured in Birmingham during the 1780s.

Priestley, in his *Essay on a Course of Liberal Education* (1765), argued that natural philosophy and chemistry should form part of the normal curriculum and said that the latter was being "daily introduced into more places of liberal education". Already in 1760 the Trustees of the Warrington Academy had set apart £100 for the purchase of physical apparatus (acquired by John Holt from the Kendal Academy) and announced their intention of adding "the more important Processes in Chemistry, especially that Part of it which has a Connection with our Manufactures and Commerce". This line had been adopted by Shaw and Lewis[4] in the 1730s and by Cullen in his first lectures at Glasgow in the 1740s. But it was not until 1762 that "Lectures upon Chemistry, principally of the Commercial Kind" were announced at Warrington for the next session. These were given by Matthew Turner who continued to lecture there until 1765. In 1766 John Aikin junior offered to lecture as often as a "sufficient number" of students called for him; he also appears to have helped the Academy "in forming an apparatus" for chemistry. The subject remained on the prospectus, and it is recorded that in 1773–74 Aikin, now in medical practice at Warrington, lectured on anatomy, physiology and chemistry. Just

[3] Aikin *et al.*, *General Biography*, 1807, p. 599.

[4] Gibbs, *Endeavour*, October, 1953, 185.

before this, Warltire had given several courses on "experimental philosophy and chemistry" in the area, and at least one at Warrington[5]. Some idea of their number is obtained from his expression of thanks to his former audiences at Whitchurch, Nantwich, Wrexham, Chester, Knutsford, Warrington and elsewhere.

There seems no doubt that the best of the itinerant lecturers looked to men like Priestley for leadership and assistance, and maintained a considerable correspondence with men of science. Priestley and Aikin refer significantly to Bacon's phrase, "Knowledge is Power", as though it were the Dissenters' watchword in further education. It was well known at Warrington and at Manchester, where it was taken into use by the Literary and Philosophical Society (founded 1781), of which Priestley and several of his friends became members[6]. The prime mover of this society, and of the club that preceded it, was Thomas Percival, F.R.S. (the first student to be enrolled at Warrington in 1757), in association with Thomas Henry, F.R.S., and others. Percival had undertaken to investigate the possible medical uses of the gases, and Henry contributed some of his experiments to Priestley's *Experiments and Observations on Different Kinds of Air*.

The full story of the itinerant lecturers cannot yet be told, for information is difficult to find and piece together. An account of Warltire has been given[7] and another of Dr. Henry Moyes[8]; both are shown to have been connected with Priestley.

As no account of Arden can be found, the following gleanings will be of interest. In 1762 James Arden, a "teacher of experimental philosophy" at Beverley, Yorkshire (where the Ardens had been known since about 1700[9]), visited Manchester and gave a course of twenty lectures "at the late Angel Inn, Market Place"[10]. John Arden, possibly a relative, was a surgeon and apothecary at Beverley[11]. In 1765 James gave twenty lectures in Birmingham,

[5] Warrington Academy, *Annual Reports of the Trustees* (microfilm copy kindly made available by the Warrington Municipal Library); *Adams's Weekly Courant*, 19 January, 1773.

[6] H. J. Fleure, *Endeavour*, October, 1947, 147; W. H. Brindley, *J. R. Inst. Chem.*, 1955, 62.

[7] D. McKie, *Endeavour*, January, 1951, 46.

[8] J. A. Harrison, *Ann. Sci.*, 1957, **13**, 109.

[9] *Notes & Queries*, 2 December, 1882.

[10] *Manchester Mercury*, 15 November, 1762.

[11] *Medical Registers*, 1779–83; *Bailey's Northern Directory*, Warrington, 1781, 139.

"at Mrs. Sawyer's Room in the Square"[12]; he also published *A Short Account of a Course of Natural and Experimental Philosophy* at Coventry in 1772 and at Birmingham in 1773, of which an "analysis" was given by his son, James Arden, junior, in 1774.

Not long afterwards Arden moved with his family to Bath, where he continued as a teacher and private tutor. In 1777 he gave at least two public courses on natural and experimental philosophy, together with a special course of lectures and experiments on different kinds of air "in an elegant Lecture-Room fitted up for that purpose, at his house in St. James's-street"[13]. Earlier that year his son was in correspondence with E. M. da Costa, F.R.S., negotiating the purchase of a collection of more than 700 fossils, some of which da Costa had been using to illustrate his own lectures[14]. There were doubtless many other lectures at Bath, for in 1782 James, junior, prepared the second edition of his *Analysis of Mr. Arden's Course*. This had a new Lecture 12 "On the Different Kinds of Air" and included accounts of artificial mineral waters and eudiometers. James, junior, appears to have been well occupied assisting his father, and possibly also his sisters, who opened a day and boarding school for girls in Catharine Place[15], where natural philosophy was taught.

A biographical account of Walker (1730?–1821) based largely on an obituary notice,[16] is given in the *D.N.B.* He is still remembered as the tutor who inspired Shelley with a love of science at the Syon House Academy and later at Eton, and as the man who gave the lie to the report in *The Times* about Priestley's part in the dinner at Birmingham that was the pretext for the riots of 1791. He was the most celebrated of the itinerant lecturers and was intimate with Priestley who arranged for him to show his "transparent orrery", or *Eidouranion*, at the Theatre Royal, Haymarket. Here only one episode will be recounted, to show the relation of the lecturers with each other and with Priestley.

In 1776 Warltire, after lecturing in Bath and Bristol and spending some time with Priestley at Calne, went on to Birmingham with a letter of introduction to Matthew Boulton[17]. There he gave three courses entitled "New

[12] *Aris's Birmingham Gazette*, 29 April, 1765.

[13] *Bath Chronicle*, 13 November, 1777.

[14] British Museum, *Add. MS.* 28,534, f.119.

[15] *Bath Chronicle*, 3 May, 1781.

[16] *Gent. Mag.*, 1821 (i), 182.

[17] McKie, *loc. cit.*, 48. Assay Office, Birmingham, letter dated 28 September, 1776. The trouble these lecturers took to obtain accurate information is exemplified by a letter from Walker to Boulton and Watt dated 23 September, 1777, now also in the Assay Office, Birmingham.

"Being a reader in philosophy I have working models of most engines for Hydraulic

continued on opposite page

Experiments upon Air"[18]. In 1780 he arranged a special course on the metals for local manufacturers[19] (April), another on minute physical objects (May), and finally a general science course (October)[20]. At about this time Priestley moved to Birmingham, and Walker and Warltire were soon in touch with him. In his reply to Walker[21], Priestley said: "As you are now within a moderate distance, I hope you will, some way or other, continue to give me a call. As my laboratory is not finished, I cannot promise to *shew* you anything, but we shall have many things to *talk* over, relating to philosophy and other matters". He then went on to say: "I wish we could get a course for you here. If you incline to it, depend upon my best services".

Walker did in fact give several lectures there in 1781. Warltire began a course on 19 March[22], with twelve lectures at the Coffee House in Cherry Street. Walker followed on 30 July with a course at the Old Assembly Room in the Square, and at the same time Warltire announced a repetition of his course in October, together with "an entire Course of General Chymistry". Walker repeated his course twice during August. In November he gave his celebrated astronomical lecture several times at the New Theatre, demonstrating his new orrery, some 15 ft. across. This was constructed by William Allen of Birmingham "who contrives and makes the best electrical machines". On his last night Walker gave a benefit for Allen[23].

[18] *Aris's Birmingham Gazette*, 4 November, 1776.

[19] *Ibid.*, 10 April, 1780; 8 May, 1780. It is not certain that the lectures on the metals were delivered, though the course was advertised several times.

[20] *Ibid.*, 23 October, 1780.

[21] Undated letter, Wellcome Historical Medical Library.

[22] *Aris's Birmingham Gazette*, 12 March, 1781.

[23] *Ibid.*, 30 July, 13 August, 5 and 12 November, 1781.

---

[17] *continued*

purposes—amongst others I have every kind of steam Engine that has been used, except the very ingenious & powerful one for which you have a patent.—a small working Model would be an useful addition to my apparatus—& I should willingly hope might extend the knowledge of its powers & utility, as I have the honour to collect all the genteel & scientific people in every place I visit.

"Now as you have mechanics of various denominations in your extensive concerns I suppose a model would be made cheaper & better by you than any where else, & if it be not out of your plan should be glad to have one made neat & on as small a scale as it could work.

"I have a general Idea of its principles from M^r^ Smeaton, but could not get it made without a section made to a scale—if therefore it do not suit you to make me a model you perhaps would be so good as suffer M^r^ Simcock to make me such a section.

"Your answer directed to me at the Hon^ble^ Boyle Walsingham's Windsor Castle would be esteemed a favour."

The next year, when Walker was in London, Arden in Bath, and Moyes in Bristol[24], the stage at Birmingham was taken first by Warltire with a course of thirteen lectures, on the "theory and experiments agreeable to the latest discoveries" in chemistry, at Cook's Coffee House[25]. On 30 September Moyes announced his impending visit to Birmingham to give "his course of lectures in natural philosophy and chymistry". Dr. Moyes, the notice said[26], was "particularly attentive to all late Discoveries, of which, by Means of an extensive Acquaintance, he never fails to have early Intelligence". This was followed by a biographical note, which does not altogether fit the account mentioned above[8]. His twenty-eight lectures began on 21 October at the Hotel. He also attended a meeting of the Lunar Society and later went to London with a letter of introduction from Priestley to Sir Joseph Banks[27].

Thus Priestley occupied an important position in this movement to take science to the public. Without the itinerant lecturers, manufacturing England in the early days of the Industrial Revolution (to which Birmingham was making no small contribution) would have been much the poorer. The fact that Priestley's door was ever open to them must have been a great boon; his reputation in the 1770s and 1780s was at its height, and these men could go to him for helpful and stimulating discussions and to be shown the experiments they wished to include in their lectures.

John Aikin said that Priestley "regarded the whole field of knowledge as common ground, to be cultivated by the united labour of individuals for the common benefit"[28]. Their mutual friend Enfield, when dedicating his *Institutes of Natural Philosophy* (1785) to Priestley, referred especially to his "comprehensive and enlarged views of science, assiduous and successful researches into nature . . . and an active spirit of philanthropy". James Keir, dedicating to him his *Treatise on the Various Kinds of . . . Gases* (1777 and 1779), called it "a small Tribute justly due to the Philosopher, who . . . has opened many new and rich sources of knowledge in Natural Philosophy". Magalhaens published his

[24] *Constitutional Chronicle*, 14 February, 1782.

[25] *Aris's Birmingham Gazette*, 10 June, 1782. In 1783 Warltire was again in Bristol, giving an extensive chemistry course in Corn Street (*Felix Farley's Bristol Journal*, 12 April, 1783).

[26] *Aris's Birmingham Gazette*, 30 September, 1782. He was said to have been blind from the age of fourteen months; his father was thought to have been a clergyman and to have died when Henry was fourteen, at which age he was placed in a university. He lived entirely on milk, vegetables and water.

[27] R. E. Schofield, *Ann. Sci.*, 1956, **12**, 118; Harrison, *loc. cit.*

[28] L. Aikin, *Memoir of John Aikin*, 1823, Vol. I, p. 371.

Description of a glass apparatus, for making mineral waters . . . (1777, 1779, 1783) as a letter to Priestley. From it we learn that some thousand of the glass generators made by W. Parker in his cut-glass factory at 69 Fleet Street had been sold and that many had been exported. This was one of the topics treated by the itinerant lecturers of this group, and the success of such machines must in part be credited to them. Indeed, it is in Walker's lectures (published in 1799) that we find a description of one of the first commercial machines for making bottled mineral waters.

REVIEWS

Alchimie et Médecine. By Alexander von Bernus. Pp. 191. Introduction and short Bibliography by Prof. H. Hunwald, and an Appendix by Dr. R. A. B. Oosterhuis. Paris: Éditions Dangles, 1960. English price 27s.

The original German edition of this book appeared in 1948 (*Alchemie und Heilkunst*, Nuremberg: Verlag Hans Carl). The seven essays together form an apologia for the clinical employment of spagyric remedies prepared in accordance with the methods of the old iatrochemists; they represent the wisdom of one who "day by day, year after year, prepares the healing arcana in his own laboratory; someone who knows what he is talking about", declares Prof. Hunwald (of the École d'Anthropologie, Paris).

Alexander von Bernus is a scholar of some distinction in the literary field. Philosopher, playwright and, above all, poet, he is a member of the German Academy who, together with Thomas Mann, Stefan George, Rainer Maria Rilke, etc., played a leading role in the creation of the young literary movement in Germany at the beginning of this century. It was a meeting with Rudolf Steiner in 1912 that roused his interest in alchemy, and after a few years' study of orthodox medicine and chemistry he founded the Soluna Laboratory for the preparation of spagyric medicines.

The chief authorities cited are Paracelsus, Sebald Schwertzer and Johann von Weidenfeld, whose techniques would seem to have been adopted by von Bernus as the pattern for his preparations. Apparently we err in thinking that the substances named by the alchemists are but masks; they bear their true names, though they do differ from the products obtained by orthodox means.

The spirit of this book is reminiscent of, for example, Dr. R. Allendy's *L'Alchimie et la Médecine* and *Le Grand-Oeuvre Thérapeutique des Alchimistes*—there is the same homœopathic application of spagyrics. The author remains indifferent to the opinions of modern scientists; indeed he admits that in the eyes of the latter his views must seem "fantastic, outdated and devoid of all objective value". In respect of the theories invoked, this is certainly a fair comment; with regard to the reputed efficacy of his preparations, we are not in a position to judge. It is, however, of interest to note that the Dutch homœopathist Dr. Oosterhuis has appended a list of modest, though impressive, claims for successes which he attributes to the products of the Soluna Laboratory.

H. J. S.

The Edge of Objectivity: An Essay in the History of Scientific Ideas. By Charles Coulston Gillispie. Pp. 562, including a Bibliographic Essay. Princeton University Press. London: Oxford University Press, 1960. Price 42s.

The difficulty which first besets the reviewer of this book is a fundamental one: what does the author mean by "objectivity"? The sub-title presupposes that the intent is to trace the evolution of scientific ideas throughout the period under consideration—from Galileo up to Maxwell, "with just a premonition of Einstein". Yet the omission of several contributors to the advancement of science, such as Bunsen and Ohm, forces one to examine more closely the main title in the hope of ascertaining more precisely the author's aim.

To the reviewer, at any rate, *The Edge of Objectivity* implies that there is to be discerned throughout the history of science an advancing front of knowledge which is ever expanding as a result of a certain approach to all problems —the important reservation being that the approach should be independent of all personal and subjective ideas. If this is so, then the same criticism must be applied as to Bacon's formulation of inductive science: the personal and speculative element can never be entirely absent, for it is an essential part of the initial process of framing a suitable hypothesis from the data of observation.

The book, which is based upon lectures given to undergraduates in the humanities at Princeton University, begins with the emancipation of scientific thought from the Aristotelian rationalism of Scholasticism, and the rise of empiricism. Copernicus' reversion to the heliocentric scheme of Aristarchus of Samos (310–230 B.C.—not the 2nd century B.C., as the author states) led through Brahe and Kepler to Galileo, whose merits and failures alike are discussed in detail. The greatest failure of Galileo—if it is not presumptuous to call it thus—was not to formulate the principle of inertia and so to forestall Newton; he "had what he needed to break the circle." Granted; nevertheless, he first presented the true values of time and space in a manner which was later to serve Newton in the development of classical dynamics, and this in itself was no mean achievement.

The chapters which follow deal with the progress of the physical and (anticipating a later term) biological sciences up to Maxwell and Darwin. The break with the teaching of Galen and Mondino (not mentioned) really began with Vesalius, for the work of Leonardo became known only at a later date; and Harvey's discovery of the function of the heart in maintaining the circulation of the blood resulted in the replacement of an age-old philosophy of life by the establishment of a single phenomenon of nature—"no vital spirit, no principle of nourishment." Incidentally, there is a surprising confusion in the description of the pulmonary circulation; it is from the right ventricle to the lungs and back to the left auricle, not the reverse, as stated on p. 66.

Upon coming to Francis Bacon one senses in the author some slight disapproval. He is not the first, of course, to feel this way; some, unqualified like Macaulay, did so through inability to appreciate the essence of the inductive method, others, such as J. S. Mill, saw the true weaknesses. Professor Gillispie's objection is on other grounds. "The true and lawful goal of the sciences", wrote Bacon, "is none other than this: that human life be endowed with new discoveries and power". This is an attitude at once humanitarian and utilitarian which, the author remarks, makes applied science the object of the search. But applied science follows the establishment of pure science, or rather, results from the utilitarian application of the knowledge acquired in the pursuance of scientific aims. Approval or disapproval of this is, of course, purely a personal matter.

Of the remaining great figures of the 17th century, Descartes, Pascal, Boyle, Hooke and Newton come in for detailed treatment, as does the intellectual *ambiance* provided by the newly-founded learned societies, the Royal Society of London and the Académie des Sciences.

The section on Newton is good and demands little comment. The author's denial that Newton occupied himself in the study of alchemy must be challenged. About one tenth of the books in his library were alchemical texts, and his

own unpublished papers show that though he originated nothing in alchemical theory, he accepted many of the tenets. Apart from this, there is little to show that the great scholar was influenced to any marked degree by the mystics with whose books he was acquainted.

From a discussion of the French Enlightenment we move into the field of chemistry, with appropriate emphasis upon the French contribution to the development of this branch of science. Curiously enough, for all his emphasis upon quantitative work and his belief in "atoms", Lavoisier's failure was that "he only weighed and classified". It was left to John Dalton to formulate clearly a chemical atomic theory.

A chapter upon "History of Nature", largely concerned with the groundwork of Lamarck and Cuvier, leads directly to Darwin and natural selection. As Professor Gillispie says, the rise of the science of genetics was the vindication of Darwin's theory. And here we discern a little more clearly the author's conception of "objectivity": genetic variations are regarded as occurring at random, which thus presupposes no causative agent for the scientist to seek out. "This is what opened the breach through which biology could follow physics into objectivity". And these chance variations "are preserved according as they work more or less effectively in objective circumstances".

The emphasis of the rest of the book is upon physics: early energetics and the laws of thermodynamics, with the implications for Darwinism—the time limit suggested for the age of the earth—are followed by a long discussion of field physics. It would take up too much space to do full justice to the author's treatment of this section, and one can only remark that it is a pity that the picture could not have been brought right up-to-date and have given us some views on the possible reconciliation between the wave theory and the corpuscular theory. The epilogue, admittedly, does review briefly the position up to the time of Einstein, with mention of Planck and Bohr, though Rutherford's name —like those of Eddington and Jeans—finds no place in the section.

The Bibliographic Essay bears impressive witness to Professor Gillispie's erudition; at the same time it defines more clearly his aims as embodied in the title, though the reviewer must confess to some residue of doubt over the fateful word "objectivity".

But this is no commonplace history of scientific ideas. Though it is extremely doubtful whether the average arts student possesses the background to assimilate this work, it is worthy of serious consideration by science students. It is highly personal in its spirit, and perhaps its great virtue will be to provoke a long and healthy discussion of the periods and figures under review—which is undoubtedly what its very scholarly author intended.

H. J. S.

A History of Greek Fire and Gunpowder. By J. R. Partington. Pp. xvi + 381, with 21 illustrations. Cambridge: W. Heffer and Sons, Ltd., 1960. Price £3 10s.

The name "Greek fire" is generally applied to certain inflammable and explosive compositions which were employed as incendiary weapons by the Byzantine Greeks at the sieges of Constantinople; but as Professor Partington has emphasized, the Byzantines never called themselves Greeks: "they claimed

to be Romans, and the name 'Greek' in their time and long afterwards had a bad reputation, like 'Levantine', or in modern French 'Grec'."

In his opening chapter, the author presents evidence in support of his thesis that the primary constituent of Greek fire was a distilled petroleum fraction made sufficiently viscous by the addition of thickening agents such as bitumen, resins, etc., but excluding the use of saltpetre; it is pointed out that "there is no evidence of the use of saltpetre in incendiary compositions in the West, before about 1250, the reason being that purified saltpetre was not known there before about 1225".

Following after a lengthy and scholarly dissemination of knowledge concerning the probable formulation of Greek fire, and a survey of such modifications in composition that would be required for its effective usage in flame-projectors, the origin of gunpowder is discussed. This section of the book begins with a detailed account and (in part) a translation of the *Liber ignium ad comburendos hostes* attributed to Marcus Graecus. Professor Partington's critical analysis of the *Liber Ignium* MSS. provides us with a mass of important information which, in itself, practically constitutes a monograph on the subject. Incidentally, one notes that Hoefer's translation (printed in his *Histoire de la Chimie*) of the *Liber Ignium* MSS. (Bibl. Nat. 7156–8) is regarded here as worthy of consideration, and that "Berthelot's criticism of it is greatly exaggerated". Subsequently, it is shown that the so-called "Marcus Graecus" was "a purely imaginary person", and that "the real author (or authors) of the final collection of this book of recipes were probably Jewish or Spanish of the 12th to 13th century".

European claimants to the invention of gunpowder, for example, Roger Bacon, and St. Albertus Magnus, may have derived their knowledge of gunpowder from Arabic sources, the author concludes; and as to the reputed medieval existence of the mysterious "Berthold Schwartz", Professor Partington has devoted an entire chapter to an exhaustive review of the available evidence on this question. The consensus of opinion is that "Berthold Schwartz" never existed except in legend.

The final chapters of this *History of Greek Fire and Gunpowder* deal with miscellaneous treatises on military arts; gunpowder and firearms in Muslim lands; pyrotechnics and firearms in China; and saltpetre—including some interesting notes on the history of soap. The book contains over 1,700 references, mostly annotated, and listed after the relevant chapters. There are four indexes, viz., of Names; Places and Nationalities; Subjects; and Greek Words.

The enormous amount of material in this treatise is of a far greater scope than may, perhaps, be implied by its title; but clearly that is all the more beneficial to the reader. On the other hand, the inevitable effect of compressing so much wealth of material into the limited space of approximately 400 pages has a tendency, in the present reviewer's opinion, to distract the reader in his assimilation of the author's narrative. Nevertheless, this work is, without doubt, the most comprehensive and authoritative account of its subject that has hitherto been published in the English language. Professor Partington's erudite scholarship, his well known style of expository analysis and argument, and his use of an extremely voluminous documentation, are outstandingly displayed in this handsomely produced book. D. G.

PUBLICATIONS RECEIVED

Chymia. Annual Studies in the History of Chemistry. Edited by Henry M. Leicester. Volume 6. Pennsylvania, University Press: London, Oxford University Press, 1960. Price 40s.

This volume opens with two articles entitled, respectively, "A Group of Akkadian Texts on Perfumery", and "Early Muslim Chemistry: Its Debt to Ancient Babylonia", by Martin Levey. In these contributions the author gives a retranslation of seven pre-classical texts, in the Akkadian cuneiform, relating to the manufacture of perfumed oils, salves and waters in Mesopotamia; and, finally, he delineates on certain similarities in Muslim and Mesopotamian philosophy: the question of the origin of Muslim alchemy is also re-examined. Under the subject-heading "Joseph Black's 'Lectures on the Elements of Chemistry' ", J. R. Partington contributes a critical and extensive account of selected items appertaining to Black's researches. In a study of "G.-F. Rouelle: An Eighteenth-Century Chemist and Teacher", by Rhoda Rappaport, Rouelle's biography and the general character of his chemical lectures is comprehensively discussed. The next contribution: "The Poetry of Sir Humphry Davy", by J. Z. Fullmer, draws our attention to this important facet of Davy's genius which, it may be added, has not hitherto received the scholarly consideration and discernment that is evidenced in the present author's essay. The remaining articles in this volume of *Chymia* are on: "Rydberg: The Man and The Constant", by Sister St. John Nepomucene, S.N.D.de N.; "Michael Tswett", by Trevor Robinson; "Chemists and the Oceans", by Edward D. Goldberg; and "Sophus Mads Jörgensen and the Werner-Jörgensen Controversy", by George B. Kauffman.

A name index is appended.

Revue d'Histoire des Sciences et de leurs Applications. Tome XII, No. 4, (October-December), 1959. Paris: Presses Universitaires de France. (Annual Subscription to Great Britain and the Commonwealth, 24s.)

This issue contains the following articles:—

Jacques Payen: "*Flos Florum* et *Semita Semite*. Deux traités d'alchimie attribués à Arnaud de Villeneuve".

Suzanne Colnort: "Un traité de thérapeutique au xvi^{e} siècle: Brouaut et la panacée alcoolique".

Jean Torlais: "Inventaire de la correspondance et des papiers de Réaumur conservés aux Archives de l'Académie des Sciences de Paris".

Jean Cousin: "L'Académie des Sciences, Belles-Lettres et Arts de Besançon au xviii^{e} siècle et son oeuvre scientifique".

Denis I. Duveen et Lucien Scheler; "Des illustrations inédites pour les *Mémoires de Chimie*, ouvrage posthume de Lavoisier".

There are sections headed "Documentation et Informations" and "Analyses d'Ouvrages"; and finally, a general index to Volume XII.

Tome XIII, No. 1. (January–March), 1960, contains articles by:—

Franck Bourdier: "Trois siècles d'hypothèses sur l'origine et la transformation des êtres vivants (1550-1859)".

Jean Rostand: "Les précurseurs français de Charles Darwin".

Albert Vandel: "Lamarck et Darwin".

Pierre-P. Grassé: "Lamarck, Wallace et Darwin".

Georges Canguilhem: "L'homme et l'animal du point de vue psychologique selon Charles Darwin".

Tome XIII, No 2. (April-June), 1960, contains the following articles:—

André Robinet: "Jean Prestet ou la bonne foi cartésienne (1648-1691)".

Georges Bouligand: "L'œuvre d'Euler et la mécanique des fluides au xviii^{e} siècle".

G. V. Bykov et J. Jacques: "Deux pionniers de la Chimie moderne, Adolphe Wurtz et Alexandre M. Boutlerov, d'après une correspondance inédite".

The Royal Society, Its Origins and Founders. Edited by Sir Harold Hartley, F.R.S. London, The Royal Society, 1960. Price 35s.